गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
फोन : +९१-८६६९६०९०४८

(Accredited by NAAC)

ATMANIRBHAR BHARAT
SWAYAMPURNA GOA

Goa University
Taleigao Plateau, Goa-403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

GU/Acad –PG/BoS -NEP/2024/98 Date: 15.05.2024

Ref: GU/Acad –PG/BoS -NEP/2023/102/35 dated 16.06.2023

CIRCULAR

In supersession to the above referred Circular, the Syllabus of Semester III to VIII of the **Bachelor of Science in Physics** Programme approved by the Standing Committee of the Academic Council in its meeting held on 06th, 07th and 21st March 2024 is enclosed. The syllabus of Semester I and II approved earlier is also attached.

The Dean/ Vice-Deans of the School of Physical and Applied Sciences and Principals of the Affiliated Colleges offering the **Bachelor of Science in Physics** programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2024.05.15 14:50:42 +05'30'

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,

1. The Principals of Affiliated Colleges offering the Bachelor of Science in Physics/Bachelor of Science in Physics (Honours) Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Physical and Applied Sciences, Goa University.
3. The Vice-Deans, School of Physical and Applied Sciences, Goa University.
4. The Chairperson, BOS in Physics.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

Programme Structure for Semester I to VIII Under Graduate Programme - Physics										
Semester	**Major -Core**	**Minor**	**MC**	**AEC**	**SEC**	**I**	**D**	**VAC**	**Total Credits**	**Exit**
I	**PHY-100* Foundations of Physics (3T+1P)**	**PHY-111 Everyday Physics (4T)**	**PHY-131 History of Physics (3T)**		**PHY-141 Basic Experimental Techniques (1T+2P)** **OR** **PHY-142 Photography (1T + 2P)**				**20**	
II			**PHY-132 Indian Contribution to Physics (3T)**		**PHY-143 House Electrical Wiring (1T+2P)** **OR** **PHY-144 PCB Designing (1T + 2P)**				**20**	**EXT-1 PHY-161 (4)***

III	PHY-200*#$ Properties of Matter and Sound (3T+1P) PHY-201 Heat and Thermodynamics (3T+1P)	PHY-211 Electricity and Magnetism (3T+1P) OR PHY-212 Energy Physics (4T)	PHY-231 Landmark experiments in Physics (3T)		PHY-241 Introduction to LaTeX and open-source plotting software (1T + 2P) OR PHY-242 Physics using Mathematica (1T + 2P) OR PHY-243 Measurements using Arduino (1T + 2P)				20	
IV	PHY-202*#$ Electronics (3T+1P) PHY-203* Optics and Modern Physics (3T+1P)	PHY-221 Communication Physics (3T+1P) OR PHY-222 Environmental Physics) (4T)							20	EXT-1 PHY-162 (4)*

	PHY-204 Classical Mechanics-I (3T+1P) **PHY-205* Mathematical Methods of Physics – I (2T)**								
V	**PHY-300*#$ Analog and Digital Electronics (4T)** **PHY-301 Atomic and Molecular Physics (4T)** **PHY-302* Physics Laboratory-I (4P)**	**PHY-321 Experimental Physics (3T+1P)** **OR** **PHY-322 Biomedical Instrumentation (4T)**				**Internship (2)**			**20**

	PHY-303*# Special Theory of Relativity (2T)									
VI	**PHY-304 Electromagnetic Theory (4T) PHY-305*#$ Quantum Mechanics-I (4T) PHY-306$ Physics Laboratory-II (4P) PHY-307* Project (4P)**	**PHY-323 Nuclear Reactor and Accelerator Physics (4T) OR PHY-324 Solid State Devices and Instrumentation (4T)**							**20**	
VII	**PHY-400*#$ Mathematical Methods of Physics-II (4T)**	**PHY-411 Introduction to Solids (4T) <u>OR</u>**							**20**	

	PHY-401* Classical Mechanics-II (4T) **PHY-402 Electrodynamics (4T)** **PHY-403*#$ Physics Laboratory-III (4P)**	**PHY-412 Introduction to Biophysics (4T) @**								
VIII	**PHY-404*$ Quantum Mechanics-II (4T)** **PHY-405*$ Statistical Mechanics (4T)** **PHY-406 Nuclear and Elementary Particle Physics (4T)**	**PHY-413 Atomic Physics (4T)** **OR** **PHY-414 Introduction to Computational Physics (4T) @**							**20**	

	PHY-407 Physics Laboratory-IV (4P)									

* - Courses to be taken by Double major programme (60%)

$ - Courses to be taken by Double major programme (40%)

- Courses to be taken for Multidisciplinary/ Interdisciplinary programme.

@ - Course Content will be notified later.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-100**
Title of the Course : **Foundations of Physics**
Number of Credits : **3L+1P**
Effective from AY : **2023-24**

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims at providing the fundamental concepts of Physics and correlating them to solve the real-world problems.	
	Theory (3 Credits)	**No. of Hours**
Content:	**Mechanics:** Standards and units, vectors: vector addition, vector subtraction, components of vector. Force, discussion of Newton's First law of motion, Newtons second law, mass and weight, Motion with constant acceleration, freely falling body, Frictional force: frictional force acting on a block moving on the flat surface and inclined surface, Newtons third law of motion, Newton's law of Gravitation. Work and energy: work, work done by varying force, work and kinetic energy, gravitational potential energy, conservative and dissipative forces, impulse and momentum, Conservation of momentum. Collisions, moment or torque of force. Rotation: Angular velocity, angular acceleration, moment of inertia, angular momentum, conservation of angular momentum. Ref 5: 1.2, 1.5, 1.6, 2.2, 2.4, 2.5, 2.8, 3.5, 3.7, 4.2, 4.4, 4.5, 6.1,6.2, 6.3, 6.4, 6.6, 7.1,7.2, 7.3, 8.1, 9.2, 9.3, 9.6, 9.12, 9.13	**9**
	Properties of Matter: Elasticity: stress, strain, elasticity and plasticity, elastic modulus, the force constant. Surface tension: Surface tension, surface energy, pressure difference across a surface film, contact angle and capillarity. Viscosity: Equation of Continuity, Bernoulli's equation, Viscosity, Poiseuille's law, Stokes law, Reynolds number. Ref 5: 10.1, 10.2, 10.3, 10.4, 10.5, 12.7, 12.8, 12.9, 13.2, 13.3, 13.5, 13.6, 13.7, 13.8	**6**
	Heat Concept of temperature, thermometers, defining of a temperature scale, The Celsius, Rankine and Fahrenheit scales, Thermal expansion, thermal stresses, heat transfer, Quantity of heat, heat capacity, experimental values of heat capacities, change of phase, conduction, convection, radiation, Stefan's Boltzmann law. Ref 5: 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 15.1, 15.2, 15.3, 15.4, 15.5, 16.1, 16.3, 16.4, 16.5	**5**
	Light	**7**

	The nature of light, Sources of light, speed of light, electromagnetic spectrum, waves, wavefronts and rays, reflection and refraction, total internal reflection, Huygens' principle, dispersion. Interference and coherent sources, interference fringe, Young's double slit experiment, interference in thin films -Newtons rings, Diffraction: Fresnel diffraction, Fraunhofer diffraction by single slit, the plane diffraction grating. resolving power of an optical instrument. Polarisation-Malus law, polarisers, Brewster's law, double refraction, optical activity. Ref 5: 38.1 ,38.2, 38.3, 38.4, 38.5, 38.6, 38.7, 38.8, 38.9, 41.1, 41.2, 41.4, 41.7 ,41.8, 41.9, 41.11, 42.1, 42.2, 42.4, 42.9	
	Sound and Acoustics Noises and Musical sounds, Loudness, how loudness is measured, Decibel, intensity of a sound. Acoustics- acoustic powers of different sources of sound, pitch, quality of sound, architectural acoustics, reverberation, acoustical demands on an auditorium, reverberation time and absorption coefficient. Sabine's law Ref 3: 11.1, 11.2, 11.3, 11.4, 11.6, 11.7, 11.8, 23.1, 23.2, 23.3, 23.4, 23.5	**6**
	Electrostatics and Magnetism Electric charge, Coulomb's law, conductors and insulators, electric field, electric field lines, Gauss's law, Electric field potential, current, resistance, electromotive force. magnetic field, magnetic field lines, magnetic dipoles, Electromagnetic induction, Faradays' law, Lenzs' law. Ref 4: 22.2, 22.3, 22.4, 23.2, 23.3, 29.1, 29.2, 29.6, 29.9, 31.3, 31.4	**7**
	Modern physics: Dual nature of light, de Broglie waves, uncertainty principle. Bohr atom, Bohr's postulates. Semiconductors: Intrinsic semiconductors, doping a semiconductor, p- type and n- type semiconductor, unbiased diode, depletion layer, Forward bias, and reverse bias. Ref 1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 1.8, 2.4,3.1, 3.7,3.8,4.5, Ref 2: 2.2, 2.4, 2.5,2.6,2.7, 2.8,2.9,2.10,2.11	**5**
	Practicals (1 Credit) **Minimum 10 experiments to be performed** 1. Introduction to measurement techniques: a) Use of Vernier callipers b) Use of micrometre screw gauge 2. Introduction to travelling microscope and finding diameter of capillary tube 3. Introduction to Spectrometer and finding angle of prism 4. Plotting of graph: slope and intercept for linear and non-linear curves.	**30**

	5. Moment of Inertia of a flywheel 6. Youngs modulus by cantilever method 7. Surface tension by capillary rise 8. Viscosity by Stokes method 9. Determination of angle of minimum deviation and refractive index of prism 10. Newton's Ring 11. Verification of Stefan's law 12. Helmholtz's resonator 13. P-N junction diode characteristics 14. Determination of Dispersive power of prism Linear expansion of solid	
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory Practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	**Text Books for Theory** 1. A. Beiser, Concepts of Modern Physics, 6th ed., McGraw-Hill, 2003 2. A. P. Malvino, Electronic Principles, 5th ed., Tata McGraw-Hill, 1996 3. D. R. Khanna and R. S. Bedi, A Textbook of Sound, Atma Ram and Sons, 1992 4. David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics, Extended Fifth edition, Wiley publication,1987. 5. Fracis W. Sears and Mark W. Zemansky, Hugh D. Young, University Physics, 6th ed., Narosa Publishing House, 1997. **Other Reference Books** 1. Jerry D. Wilson Physics a practical and conceptual approach, Second Edition, Saunders College Publications1986. 2. N. Subramanyam, Brij Lal, A textbook of Sound, Second Edition, Vikas Publishing House Pvt. Ltd., 2016. 3. P. G. Hewitt, Conceptual physics, 12th ed., Pearson, 2015. **Text Books for Practical** 1. C. L. Arora, B.Sc. Practical Physics, S. Chand Publication, 2010 2. P. S. Bangui, V. V. Pathak, C. G. Patil, T. S. Y. Ram, N. C. Garach Handbook of Practical Physics, Sheth Publishers Pvt. Ltd. 1992	
Course Outcomes:	Student will be able to 1. Recall the fundamental concepts of Physics for critical thinking & problem solving. 2. Understand the fundamental concepts to comprehend the physical phenomena happening around us. 3. Apply fundamental concepts of Physics to solve these problems. 4. Analyse the concepts in different scenarios.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-111**
Title of the Course : **Everyday Physics**
Number of Credits : **4**
Effective from AY : **2023-24**

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to enhance the perception of physical concepts and develop deeper understanding of the world we interact with every day.	
		No. of Hours
Content:	**Exploring the laws of motion** Newton's first law of Inertia, Net Force, the equilibrium rule, speed, velocity, Acceleration, how fast, friction, Mass and weight, Newtons second law of motion, when acceleration is g, when acceleration is less than g, Forces and interaction, Newtons third law of motion, Momentum, Impulse, Bouncing, conservation of momentum, collisions, work, Power, Potential, Kinetic energy, conservation of energy. Ref. 1: 2.3, 2.4, 2.5, 3.2, 3.3, 3.4, 3.5, 4.2, 4.3, 4.4, 4.5, 4.6, 5.1, 5.2, 5.3, 6.1, 6.2, 6.4, 6.5, 6.6, 7.1, 7.2, 7.3, 7.5.	**7**
	Physics of circular motion Circular Motion, Rotational inertia, Torque, Center of mass and center of gravity, Centripetal force, centripetal force, centrifugal force, Angular Momentum, conservation of angular momentum. Ref. 1: 8.1, 8.2, 8.3, 8.4,8.5,8.6, 8.7, 8.8, 10.1.	**6**
	Wonders of gravitational force The universal law of gravity, the universal gravitational constant, Inverse square law, weight and weightlessness, ocean tides, black holes. Ref.1: 9.1, 9.2, 9.3, 9.4, 9.5, 9.7	**5**
	Understanding Matter from solid to plasma Solids: Density, Elasticity, tension and compression, Scaling. Liquids: Pressure, Buoyancy, Flotation, Archimedes principle, what makes object sink and float, Surface tension, Capillarity, Gases: The Atmosphere**,** atmospheric pressure, Barometers, Bernoulli's Principal, Plasma. Ref. 1: 12.2, 12.3, 12.4, 12.6, 13.1, 13.3, 13.4, 13.5, 13.6, 13.8, 13.9, 14.1, 14.2, 14.5,14.6.	**6**
	Dynamics of heat Temperature, heat, specific heat Capacity, Thermal Expansion. Heat Transfer: Conduction, Convection and Radiation. Newtons law of cooling. Ref. 1: 15.1, 15.2, 15.3, 15.5, 16.1, 16.2, 16.3. 16.4	**6**
	The wonders of sound Wave motion, wave speed, wave interference, Doppler Effect, Sound in air, forced vibrations, resonance, interference, Beats, Music, Pitch, Sound intensity, Musical Instruments.	**7**

	Ref. 1: 19.3, 19.4, 19.5, 19.6, 20.2, 20.5, 20.6, 20.7, 20.8, 21.1, 21.2, 21.3, 21.5	
	Fun with Electricity and Magnetism Electricity: electric charges, Coulomb's law Conductors and Insulators, electric field, electric energy storage, voltage sources, electrical Resistance, direct and alternating current, Electric power, Lamps. Magnetism: Magnetic poles, magnetic fields, Electric current and magnetic field, Electromagnets, Faraday's law, Electric Motors, Electric Generators, Power Production, Transformers. Ref. 1. 22.1, 22.2, 22.4, 22.5, 22.8, 23.2, 23.3, 23.5, 23.7, 23.8 24.1, 24.2, 24.3, 24.5, 24.6, 24.7, 24.9, 25.2, 25.3, 25.4, 25.5.	**8**
	The Magic of Light Electromagnetic wave, Electromagnetic spectrum, transparent materials, opaque materials, shadows, Seeing Light, colour, selective reflection, selective transmission, mixing coloured light, natural phenomenon like why sky is blue? Why Sunsets Are Red? Why Clouds Are White? Why Water Is Greenish Blue? Reflection, Refraction, Dispersion and Rainbows, total internal reflection, Lenses and Mirrors. Ref. 1: 26.1, 26.3, 26.4, 26.5, 26.6, 27.1, 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 28.1, 28.2, 28.3, 28.5, 28.6, 28.7,28.2.	**7**
	Unlocking secrets of an atom Quantization of energy, wave particle duality, complementarity, predictability and chaos. Bohr Model of the atom, concept of electron waves, Schrodinger's wave equation. X-ray and radioactivity, alpha, beta and gamma rays, environmental radiation, doses of radiation, radioactive traces, The atomic nucleus and the strong force, transmutation of elements, radioactive half-life. Ref. 1: 31.2, 31.4, 31.8, 32.4, 32.5, 32.6, 33.3, 33.1, 33.2, 33.3, 33.4, 33.5, 33.6	**8**
Pedagogy:	Lectures/ tutorials or a combination of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	**Text Books** 1. P. G. Hewitt, Conceptual physics, 12th ed., Pearson, 2015. **Other reference Books** 2. G. Venkataraman, Why are things the way they are? University Physics, 2017. 3. Jerry D. Wilson Physics a practical and conceptual approach, Second edition, Saunders college publications, 1986.	
Course Outcomes:	Student will be able to 1. Recall fundamental concepts in Physics and connect them in everyday life 2. Describe the fundamental concept to understand the physical phenomena happening around us. 3. Apply fundamental concepts in Physics to analyse these phenomena. 4. Correlate the concepts of Physics in other branches of science.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-131**
Title of the Course : **History of Physics**
Number of Credits : **3**
Effective from AY : **2023-24**

Pre-requisites for the Course:	Nil	
Course Objectives	To acquaint the student about the development of Physics.	
		No. of Hours
Content:	**Unit 1**: An introduction to the Science of Galileo	**5**
	Unit 2: Halley, Kepler and Newton and their Physics	**6**
	Unit 3: Isaac Newton his Mechanics and his Gravity	**6**
	Unit 4: Boltzmann, Maxwell and other giants of Classical Physics	**6**
	Unit 5: Coulomb, Faraday, Maxwell: Electricity and Magnetism	**6**
	Unit 6: Atomic theory, the periodic table, Mendeleev, Dalton, and Lavoisier	**6**
	Unit 7: The wave-particle duality of light, Max Planck, Neils Bohr, Albert Einstein and Quantum Physics	**10**
Pedagogy:	Lectures/Demonstrations/Short movies. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. I. Glynn, Elegance in Science, Oxford University Press 2010 2. J. Gribbin and M. Ribbin, Out of the Shadow of a Giant, William Collins, 2018. 3. J. Gribbin, Science a History, Penguin, 2009. 4. M. Mosley. and J. Lynch, The Story of Science, Octopus Publishers, 2010. 5. T. Crump, Science as seen through the development of scientific instruments, Running Press, 2001. 6. Z. Jed Buchwald, Robert Fox - The Oxford Handbook of the History of Physics, Oxford University Press, 2014.	
Course Outcomes:	Student will be able to 1. Understand that the development of Physics was incremental. 2. Realise that a few great men and women influenced the development of physics. 3. Analyse different laws and theories of physics and their impact on modern science. 4. Understand that results that could not be explained often led to the introduction of radical new physics.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-132**
Title of the Course : **Indian Contribution to Physics**
Number of Credits : **3**
Effective from AY : **2023-24**

Pre-requisites for the Course:	Nil	
Course Objectives	To create awareness of Indian contribution to the subject of Physics.	
Content:		**No. of Hours**
	Jagdish Chandra Bose: biography, Experiments on refraction, diffraction & polarization, radio wave detector. Contribution to Biology.	**5**
	Chandrashekhar Venkata Raman: biography, Molecular diffraction of light, Raman effect. Raman at the Indian Institute of Science. Fascinating colours of butterflies.	**5**
	Meghnad Saha: biography, Saha's Ionization Formula. Saha's views on National Problems (Atomic Energy and River physics & Flood) and Social Concerns (Science & Culture and Freedom Movement). Calendar Reform.	**4**
	Satyendra Nath Bose: biography, Bose and his Statistics, Planck's law & hypothesis of light, Bose Condensation	**5**
	Homi Jehangir Bhabha: biography, cosmic rays, birth of Atomic energy research in India, Contributions to National science (ISRO, Electronics, Pure and Applied Science Research and Molecular Biology), Bhabha Atomic Research Centre.	**5**
	Subrahmanyan Chandrasekhar: biography, Birth and death of a star, blackhole, neutron star and white dwarf.	**4**
	Sivaramakrishna Chandrasekhar: biography, early work on crystalline optical activity and X-ray diffraction, Liquid crystals.	**4**
	Jayant Narlikar: biography, Cosmology, Inter University Centre for Astronomy and Astrophysics (IUCAA).	**4**
	Ennackal Chandy George Sudarshan: biography, Quantum optics.	**4**
	Vikram Sarabhai: biography, PRL, Indian Space Programme, Atomic Energy Commission and other organizations, Indian Space Research Organization	**5**
Pedagogy:	Lectures/ tutorials or a combination of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. A Jayaraman, C. V. Raman A Memoir, Affiliated East-West Press (1990) 2. C N R Rao and Indumati Rao, Founders of Modern Science in India, Indian Academy of Sciences (2021) 3. Chintamani Deshmukh, HOMI JEHANGIR BHABHA, National Book Trust (2010) 4. D P Sen Gupta, Meher H Engineer, Virginia Anne Shepherd, Remembering Sir J.C. Bose, World Scientific (2009) 5. G. Venkataraman, BHABHA AND HIS MAGNIFICIENT OBSESSIONS, Universities Press (1994)	

	6. G. Venkataraman, Bose and His Statistics, Sangam Books Ltd (1993) 7. G. Venkataraman, Chandrasekhar and His Limit, Universities Press (1992) 8. G. Venkataraman, Raman and his Effect, Universities Press (1995) 9. G. Venkataraman, SAHA AND HIS FORMULA, Universities Press (1995) 10. Kameshwar C. Wali, A Scientific Autobiography: S. CHANDRASEKHAR, World Scientific (2011) 11. Patrick Geddes, The Life and Work of Sir Jagadish C. Bose, Pharos Books (2022) 12. Pramod V. Naik, Meghnad Saha: His Life in Science and Politics, Springer 2017 13. Resonance – Journal of Science Education, https://www.ias.ac.in 14. Santimay Chatterjee, Enakshi Chatterjee, SATYENDRA NATH BOSE, National Book Trust (1976). 15. Sivaramakrishna Chandrasekhar, https://wwws.rri.res.in/htmls/library/imprints_collection/bios/chandrasekhar.html 16. UNESCO Kalinga Prize Winner – 1996, https://www.drcrmishra.com 17. Vikram Sarabhai - The Legend Unveiled, publisher Vijnana Bharati (2017)
Course Outcomes:	Student will be able to 1. Decipher contributions of Indians to Physics. 2. Understand the role played by some of them in building modern India. 3. Gain knowledge of Indian Atomic Energy Programme and Indian Space programme. 4. Get inspired from the biographies of these men.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-141**
Title of the Course : **Basic Experimental Techniques**
Number of Credits : **1L + 2P**
Effective from AY : **2023-24**

Pre-requisites for the Course:	NIL	
Course Objectives:	The course will enable students to acquire required skills to understand basic experimental techniques and use them in a physics laboratory.	
Content:	**Theory (1 Credit)**	**No. of Hours**
	Unit I: Units and Measurements. M.K.S., C.G.S., F.P.S. & S.I system of units (basic introduction) Elementary ideas of measurements using Vernier Calipers, Micrometer Screw Gauge, Spherometer, travelling microscope, difference between precision and accuracy. **Measurement of mass** using digital balance. **Measurement of Temperature** Thermometer, thermocouple, metal and semiconductor devices, Different scales of temperature (Celsius, Kelvin, Fahrenheit, and Reaumur).	**4**
	Unit II: Theory of Errors. Arithmetic mean, absolute error, relative error, percentage error. Expressing results of an experiment including errors. propagation of errors. Plotting of graphs.	**3**
	Unit III: Physical Optics. Convex & concave mirror and their focal length, Convex & concave lenses and simple theory about their focal length, combination of lenses.	**3**
	Unit IV: Basic Electrical and Electronic components Basic understanding and use of components: Transformers, switches, fixed resistors, potentiometers, rheostats, capacitors, inductors, diodes, Zener diodes, LED's, transistors and relay.	**2**
	Unit V: Basic Electrical and Electronic Instruments Basic understanding and use of instruments /devices: Electrical tester, Digital Multimeter, Digital LCR meter, breadboards, Variac, DC Power supplies (fixed voltage, dual voltage & variable voltage), Function generator, CRO (Cathode Ray Oscilloscope) and DSO (Digital Storage Oscilloscope)	**3**
	Practicals (2 Credits) **General Physics:** 1. Use of Vernier Calipers and Micrometer Screw Gauge. 2. Use of Travelling Microscope. 3. Use of Spherometer. 4. Measurement of temperature using different devices. 5. To determine Focal lengths of convex and concave mirrors. 6. To determine Focal lengths of convex and concave lenses. 7. Use of Spectrometer to determine angle of Prism.	**60**

	8. Plotting of graphs from given Data. 9. Calculation of percentage error in an experiment using given data and expressing the result of the experiment using errors. 10. Use of virtual lab software for experimental demonstrations. (**Only for demonstrations**) **Electrical/Electronics:** 1 Familiarization and use of Digital Multimeter for testing fixed resistors, switches, potentiometers, diodes, Zener diodes and transistors. 2 Familiarization and use of Digital LCR meter for testing different types of inductors and capacitors. 3 Use of Variac and testing of different types of transformers (step down) and rheostats. 4 Familiarization & use of Breadboard and construction of simple circuits on the breadboard. 5 Familiarization and use of Function generator, CRO & DSO and measurement of voltage (DC/AC), period and frequency. 6 Familiarization, use and testing of regulated power supplies (fixed, dual & variable voltage). 7 Construction and testing of simple DC power supply using transformer, diodes and capacitor. 8 Use of virtual lab software for experimental demonstrations. (**Only for demonstrations**)	
Pedagogy:	Lectures, Demonstrations, Problem Solving, Laboratory work & use of Virtual lab Software (open source) for experimental demonstrations.	
References/ Readings:	1. A. P. Malvino, Electronic Principles, Tata McGraw Hill (2007) 2. B. K. Sharma, Modern *ABC of Physics* Class-11, Modern Publishers. 3. Charles Platt, Easy Electronics, Maker Media, 2017 4. Charles Platt, Encyclopaedia of Electronic components (Volume I), OReilly Media (2012) 5. D. Chattopadhyay, P. C. Rakshit. *An Advanced Course in Practical Physics*, New Central Book Agency, 1990 6. H. S. Kalsi, Electronic Instrumentation, TMH (2004). 7. Laboratory Manual Physics Class XI, First Edition June 2010 Asadha 1932, NCERT Publisher. 8. Laboratory Manual Physics Class XII, First Edition June 2010 Asadha 1932, NCERT Publisher. 9. N. N. Bhargava, D. C. Kulshrestha and S. C. Gupta, Basic Electronics and Linear Circuits, TMH (1984). 10. N. Subrahmayam and N. Brijlal, Text Book of Optics, S. Chand & Company Ltd. (1991). 11. *NCERT PHYSICS* CLASS 11 PART I & II, NCERT publication. 12. *NCERT PHYSICS* CLASS 12 PART I & II, NCERT publishers. 13. Peter J. Nolan, Raymond E. Bigliani, Experiments in physics, Surjeet Publications. 14. Satish K. Gupta, Modern *ABC of Physics* Class-12 Modern Publishers. 15. *V. K. Mehta*. Rohit Mehta, *Principles of Electronics (*Revised Edition), S. Chand Publishers.	

	Note: A minimum five experiments from each section are to be performed for the Semester.
Course Outcomes:	Student will be able to 1. Identify different components and Experimental instruments 2. Gain Basic understanding of Experimental instruments. 3. Develop Skills in performing Physics experiments. 4. Calculate errors in an experiment and other parameters related to the experiment.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-142**
Title of the Course : **Photography**
Number of Credits : **1L + 2P**
Effective from AY : **2023-24**

Pre-requisites for the Course:	NIL	
Course Objectives:	1. Familiarize the student with concepts and content of photography instruments (cameras, lenses and lighting equipment) 2. Introduce the professional usages of photography equipment 3. Learn optimization of equipment capabilities 4. Create capability to generate professional digital photographic content. 5. Provide hands on practical experience via structured photoshoots 6. Generate artistic talent in a scientific way	
		No. of Hours
Content:	**Theory (One credit)** 1. **Introduction to photography**, Definition of photography, Physics of photography, History and developments in photography, Types of photography, Digital photography. 2. **Camera Basics**, Types of cameras, introduction to common brands of cameras, Camera Controls, basic camera settings, Basic camera operations. 3. **DSLR Cameras**, Crop sensor, full frame & medium format cameras. Detailed operational procedure of a DSLR Camera and shooting modes 4. **Exposure** 5. **Aperture & Shutter Speeds** 6. **ISO**: Exposure compensation, Concept of high- and lowkey photographs 7. **Light Meter**, TTL concept 8. **Depth of Field**, white balance & colour compensation 9. **Composition rules** 10. **Lenses,** Importance of lens in a camera, focal length of camera lenses and its effects on photographs. Types of lenses. (Prime lens, zoom lens & tilt lens) Categorization of lenses (kit lenses, micro, macro, wide angle & telephoto lenses). 11. **Lighting**, Natural lighting, artificial lighting, speed lights, studio strobes, light modifiers, colour gels Effect of lighting on photographs, Fill light, back light, Rembrandt lighting; butterfly lighting, golden hour and sun set photography 12. **Flash Photography** TTL, high speed sink, Composition tips and Shooting at Night 13. Filters, Tripod, & Camera Accessories 14. Introduction to a photo editing software (adobe light room)	**15**
	Practical (any 20) (two credits)	**60**

	1. Time-lapse photography: capture a sequence of images over time to create a time-lapse video. 2. Light painting: use long exposure times and light sources to create unique and artistic images. 3. U-V light photography. create an object photograph using ultra violet light 4. High-speed photography: capture fast-moving objects or events using fast shutter speeds. 5. Macro photography: capture close-up images of small objects or details. 6. Astrophotography: capture images of the night sky, stars, and galaxies. 7. HDR photography: combine multiple exposures of the same scene to create a high dynamic range image. 8. Bokeh photography: create images with a shallow depth of field and beautiful bokeh. 9. Still life photography: capture images of objects arranged in a still life composition. 10. Portrait photography: capture images of people in various poses and settings. 11. Landscape photography: capture images of the natural environment, such as mountains, forests, and oceans. 12. Street photography: capture candid images of people in public spaces. 13. Black and white photography: experiment with black and white photography to create dramatic and moody images. 14. Infrared photography: capture images using infrared light to create unique and surreal images. 15. Double exposure photography: combine two or more images to create a unique and artistic image. 16. Panoramic photography: capture wide-angle images of landscapes or cityscapes. 17. Silhouette photography: capture images of subjects against a bright background to create striking silhouettes. 18. Still image/video hybrid: combine still images and video footage to create a unique hybrid. 19. Tilt-shift photography: use a tilt-shift lens to create a miniature effect in your images. 20. High-key and low-key photography: experiment with high-key and low-key lighting to create images with bright or dark tones. 21. In-camera multiple exposures: experiment with multiple exposures using the camera's multiple exposure function to create unique and artistic images. 22. Night Photography: Use long exposures and capture a subject at night. 23. Wildlife Photography: Take photos of animals in their natural habitats	

	24. Product Photography: Take photos of products for advertising or e-commerce purposes. 25. Sports Photography: Capture action shots of athletes in various sports, such as basketball or soccer. 26. Fashion Photography: Take photos of clothing and accessories for fashion magazines or advertising. 27. Documentary Photography: Use photography to tell a story or document a particular event or social issue. 28. Concert Photography: Take photos of musicians and performers during concerts or live shows. 29. Architectural Photography: Capture buildings, interiors, and landscapes for architectural purposes or real estate. 30. Food Photography: Take photos of food for menus, cookbooks, or social media. 31. Aerial Photography: Capture photos from above using drones or other aerial vehicles. 32. Underwater Photography: Take photos of marine life and scenery underwater using waterproof cameras or housings	
Pedagogy:	Lectures, Demonstrations and Laboratory work	
References/ Readings:	1. 50 Photo Projects - Ideas to Kickstart Your Photography, Lee Frost, David & Charles; 2009 2. Brenda Tharp, Extraordinary Everyday Photography: Awaken Your Vision to Create Stunning Images Wherever You Are, Amphoto Books 2012 3. Bruce Barnbaum, The Art of Photography: An Approach to Personal Expression, Photographic Arts Editions in cooperation with Rocky Nook Inc 2010 4. Bryan Peterson, Understanding Exposure, 3rd Edition: How to Shoot Great Photographs with Any Camera, Random House India Edition: 3rd Edition, 2010 5. Craig Alesse, Basic 35mm Photo Guide: For Beginning Photographers 5th Edition, Amherat Media Inc. 2001 6. David Busch's Mastering Digital SLR Photography (David Busch's Digital Photography Guides) 3rd Edition, David D. Busch, Course technology PTR 2012 7. Jim Miotke, Better Photo Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro 1st Edition, Amphoto Books 2010 8. Michael Freeman, The Photographer's Eye: Composition and Design for Better Digital Photos 1st Edition, Focal Press; *1st edition* (May 23, 2007); 9. Scott Kelby, Scott Kelby's Digital Photography Boxed Set, Volumes 1, 2, and 3 1st Edition, Peachpit Press, 2007, 2009 10. Tom Ang, How to Photograph Absolutely Everything: Successful Pictures from Your Digital Camera, DK; Reprint edition 2009	
Course Outcomes:	Student will be able to 1. Understand the fundamental concepts, theoretical formulations and practical applications pertaining to the topics listed in syllabus.	

	2. Attain capability to evaluate and calculate all major aspects pertain to a professional photoshoot. 3. Create professional digital photographic content by optimal utilization of equipment potentials. 4. Draw the geometries of practical photoshoot problems 5. Deduce the common tricks and techniques practiced in a professional photoshoot. 6. Transform into a professional photographer.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-143**
Title of the Course : **House Wiring**
Number of Credits : **1L + 2P**
Effective from AY : **2023-24**

Pre-requisites for the Course:	NIL	
Course Objectives:	The course will impart necessary skills for basic electrical and house wiring.	
		No. of Hours
Content:	1. **Basic Electrical circuits** - Ohm's Law, Laws of resistance - Resistances in series and parallel - Voltage and current division - Kirchhoff's Laws and applications.	**1**
	2. **Electric Circuits and Connections** Concept of single-phase wiring, Concept three-phase wiring, Star and Delta connections, Resistive, Inductive & Capacitive loads	**2**
	3. **Electrical Measuring Instruments** PMMC & MI meter (Ammeter, Voltmeter), Range extension Study of Multimeter (Digital/Analog), Wattmeter - P.F. meter, Energy meter (Digital/analog) - Insulation Tester (Megger), measurements using Oscilloscope	**2**
	4. **Electrical Wiring** Introduction - Common Electrical wiring Accessories, their specifications – Different methods of measuring the values of resistance - Circuit connection, Solders, flux, soldering and de-soldering technique - Wire Crimping	**2**
	5. **Switches and Cables** Explanation of switches - Lamp holders, plugs and sockets - Conductors, Strands, Cores of Cable - Insulation of a Cable - Types and Selection of cables	**1**
	6. **Circuit Breakers and Panel Board** Brief description of Fuse - MCB's, MCCB's	**1**
	7. **Lighting and Illumination** Basics of illumination - Types of light (GLS, FTL, CFL, LED, MVL etc.) - Construction, working and applications - Light selection by manual method - IE rules	**2**
	8. **Fan and Heating Appliances** Types and selection of fans used at home - Ceiling fans, Table fan, Exhaust and Geysers Fan - Trouble shooting and servicing of fans	**2**
	9. **Electrical Hazards and Basic Safety** Electrical Hazards and its effects - Basic safety introduction - Personal protection Hazard identification and avoidance	**2**
	Practicals 1. Handling and measurements using voltmeter, ammeter, wattmeter, oscilloscope, multimeter	**60**

	2. Handling, identification of various electrical wires, switches, sockets of various ampere or wattage rating, fan control 3. Resistors series and parallel connection and measurement of resultant values using multimeter 4. Identify types of wires, cables and verify their specifications. 5. Make simple straight twist and rat-tail joints in single strand conductors. 6. Making a switch/extension board 7. Making a table lamp with ON/OFF switch 8. Testing of earthing leakage using voltmeter and test lamp 9. Drawing up a plan for house wiring with load calculations 10. Assembling/disassembling a ceiling fan, table fan, fixing tubelights, iron 11. Basic fault finding for lights, fans, electrical wiring, iron 12. Study of transformers, variacs 13. Handling of electrical drill, types of drill bits, wall wiring (creating an electrical point with switch, MCB, fuse) 14. Drawing for proper illumination of a room, placement of lights and fans 15. Install Earthing pipes/ plates 16. Light fitting for showcase 17. Identify the types of fuses their ratings and applications 18. Estimation of cost for electrical wiring of a room and service charges 19. Basic electrical safety procedures 20. Stair case wiring 21. Connect 3 single phase transformers for 3 phase operation of delta delta /delta-star /star-star /star-delta 22. Basics of soldering 23. Connection of remote ON/OFF control of switches	
Pedagogy:	Lectures, Demonstrations, Laboratory work	
References/ Readings:	**Text Book** 1. David W Rongey Home Electrical Wiring: A Complete Guide to Home Electrical Wiring Explained by a Licensed Electrical Contractor, Home Electrical Wiring Publication, 2013. **Reference books** 2. Basic Electrical House Wiring | abdulaziz hassan - Academia.edu 3. House Wiring Diagram - Everything You Need to Know | EdrawMax Online 4. https://extremehowto.com/electrical-101-homeowner/ 5. https://www.coynecollege.edu/learn-basics-of-home-electrical-wiring/ 6. https://www.electricaltechnology.org/2013/09/electrical-wiring.html 7. M Lotia, Modern Basic Electrical & House Wiring Servicing Paperback – Hindi Edition Bnp Publications 2012	
Course Outcomes:	Student will be able to 1. Acquire hands-on training on handling and using equipment used for household wiring	

	2. Perform simple electrical jobs 3. Undertake home wiring 4. Design proper lighting and fan placements for a room 5. Check for proper earthing and electrical safety 6. Find simple faults of electrical gadgets

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-144**
Title of the Course : **PCB Designing**
Number of Credits : **1L + 2P**
Effective from AY : **2023-24**

Pre-requisites for the Course:	NIL	
Course Objectives:	The course will prepare the student/s to develop skills of the design and implementation of electronic circuits and fabricate the same using PCB designing for a prototype and/or circuit production in Electronic Industry.	
Content:		**No. of Hours**
	Introduction: Practical acquaintance with techniques for measurement and use of necessary tools and instruments such as CRO, Signal generator, Multimeter, Power supply.	**2**
	PCB components: Exposure to different types of components: diodes, resistors, capacitors, transistors, operational amplifiers, field effect transistors, unijunction transistor and testing of various components.	**2**
	Breadboard theory: Circuit implementation using breadboards, soldering and de-soldering techniques, construction of circuits using Vero boards.	**2**
	PCB designing: Need for PCB design, various types of PCB designs such as single and multilayer, PCB material.	**2**
	Schematic designing: Introduction to schematic design, understanding various symbols and their respective functions, circuit designing, tracing and artwork on copper clad boards, technique of etching on copper clad boards.	**2**
	PCB layout design: PCB layout design process, layout and rules, cleaning of PCB, PCB drilling, mounting/placement of components, soldering and testing of PCB circuit.	**2**
	Introduction to PCB design software (Opensource software) Create circuit board layouts with any software such as: FreePCB, DesignSpark PCB, Osmond PCB, Express PCB, KiCad (multi-platform PCB design package), ZenitPCB, EasyEDA, etc.	**3**
	Practical Component: 1. Practical acquaintance with instrumental techniques for measurement: CRO, Signal generator, Multimeter. 2. Testing of various components: Resistors, capacitors, transistors, diodes, FET, UJT etc. 3. Constructing a given circuit using a breadboard and testing the same for the required output/s. 4. Soldering and de-soldering technique, constructing circuits using vero boards. 5. Circuit designing, tracing and Artwork on Copper Clad board or circuit board layouts using opensource software. 6. Etching of copper clad boards using ferric chloride and commonly used precautions to be taken.	**60**

	7. Cleaning of PCB, PCB drilling, mounting of components. 8. Soldering and testing of designed circuits on PCB.	
Pedagogy:	Lectures, Demonstrations, Laboratory work, use of opensource software for practicals.	
References/ Readings:	1. Charles A. Harper: Handbook of Electronics Packaging, Tata McGraw-Hill, 2005 2. R. S. Khandpur: Printed Circuit Boards: Design, Fabrication, Assembly and Testing, Tata McGraw-Hill, 2017. 3. Walter C Bosshart: Printed Circuit Boards: Design and Technology, Tata McGraw-Hill 2013.	
Course Outcomes:	1. Develop the necessary skills in drawing circuit diagrams and use techniques of circuit analysis for designing a given circuit as per given specifications. 2. Use a Breadboard for a prototype implementation of circuits, test the performance of the circuit design using testing and measuring instruments (Multimeter, CRO, power supply etc). 3. Develop soldering and de-soldering techniques and develop the necessary skills in etching PCB's. 4. Create and fabricate a PCB, construct and test the circuit design on PCB's.	

Semester III & IV
Name of the Programme : B.Sc. Physics
Course Code : PHY-200
Title of the Course : Properties of Matter and Sound
Number of Credits : 3L+1P
Effective from AY : 2024-25

Pre-requisites for the Course:	NIL	
Course Objectives:	To learn mechanical properties of solids and fluids and to relate it to day today observations. Understand concept of oscillation and apply it explain to sound waves and related phenomenon.	
		No. of Hours
Content	**Properties of Matter: Elasticity** Hook's law, Stress Strain diagram, Elastic behaviours of solids in general (Elastic after effect, Elastic hysteresis, Elastic fatigue), working stress and factor of safety, factors affecting elasticity (effect of hammering, rolling and annealing, effect of impurities, effect of change of temperature) Moduli of Elasticity, Equivalence of shear to compression and extension at right angles, Deformation of cube (Bulk modulus, modulus of rigidity, Young's modulus) Relation connecting elastic constants, Poisson's ratio and its relation with bulk modulus and modulus of rigidity, limiting values of Poisson's ratio. Twisting couple on a cylinder, Beams, Bending of beams, flexural rigidity. Cantilever (rectangular bar), depression in a beam supported at ends and loaded in the middle.	**12**
	Fluid Flow Streamline flow, turbulent flow, Equation of continuity of flow, energy of a liquid in flow, Bernoulli's theorem, Bernoulli's equation, applications of Bernoulli's theorem: Torricelli's theorem and Venturimeter, Viscosity, coefficient of viscosity, Critical velocity, Reynold's number and its significance, Poiseuille's equation for flow of a liquid through a horizontal tube and its corrections, fluid flow, Stokes law, Ostwald viscometer, viscosity of gases: Mayer's formula.	**10**
	Sound: Simple Harmonic Motion Simple harmonic motion, differential equation for simple harmonic motion and its solution, relation of velocity and acceleration to displacement, superposition of SHM in a straight line: Two SH vibrations of equal periods but different amplitudes, any number of SH vibrations of same period but different amplitudes. Lissajous figures (concept only). Beats, applications of beats, distinction between stationary interference and beats.	**7**
	Wave motion Transverse and longitudinal waves, mechanical analogy of longitudinal waves, progressive wave and its general equation, particle velocity and acceleration, relation between wave velocity and particle velocity, differential equation of wave motion, energy of a plane progressive wave.	**6**

	Velocity of sound waves Velocity of longitudinal waves in fluids, Newtons formula for velocity of sound in air, Laplace's correction, effect of pressure, density and temperature, Velocity of longitudinal wave in a rod. Kundt's tube experiment to find velocity of sound in a gas or a solid rod. Doppler's effect: Source in motion and listener and medium at rest, Listener in motion and source and medium at rest, Source and listener both in motion and medium at rest. Effect of wind on the pitch of sound Indirect approach of source and listener.	**10**
	Practical (Minimum 08 experiments to be performed) 1. Bending of beams-double cantilever: determination of Young's modulus. 2. Determination of Y and η using Flat spiral spring. 3. Modulus of rigidity by torsional pendulum 4. Verification of Bernoulli's theorem 5. Viscosity of fluid by stokes method. 6. To determine the viscosity of fluids by viscometer 7. To measure the velocity of flow using Pitot tube. 8. Superposition of two mutually perpendicular simple harmonic oscillations -Lissajous figures using CRO 9. To determine the velocity of sound in air (gas) using Kundt's tube set up. 10. To determine the young's modulus of the material of rod using Kundt's tube set up. 11. Velocity of sound in air using Helmholtz resonator 12. Frequency of AC cycle using amplitude resonance 13. Velocity of sound by forming stationary wave using CRO 14. Falling plate experiment to find frequency of the tuning fork.	**30**
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. D. Chattopadhyay, P. C. Rakshit, Vibrations, Waves, And Acoustics, Books & Allied (P) LTD, (2020) 2. D. R. Khanna and R. S. Bedi, Text book of Sound Atma Ram, New Delhi, 1969. 3. D. S. Mathur, Elements of Properties of Matter, S. Chand and Sons, (2013). 4. D.C. Tayal, University Practical Physics, Himalaya Publishing House, (2000) 5. M Ghosh and B Bhattacharya, Oscillations and Acoustics, S.Chand & Co Ltd. (1976) 6. Merle Potter, David Wiggert, Fluid Mechanics, Schaum Outline Series, (2008). 7. N. Subrahmanyam and Brij Lal, A textbook of sound, S. Chand publisher, (2018) 8. R K Bansal, Fluid Mechanics, Firewall Media, (2005). 9. S. P. Puri, Text book of Vibrations and Waves, McMillan India ltd, 2nd edition, (2004).	

Course Outcomes:	Student will be able to 1. Understand fundamental concepts of mechanical properties of solids and liquids and understand concepts of oscillatory motion. 2. Analyze beams subjected to stress and estimate their deformation. 3. Interpret interference of sound and explain formation of beats. 4. Analyze wave motion to evaluate speed of sound.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY 201**
Title of the Course : **Heat & Thermodynamics**
Number of Credits : **3L+1P**
Effective from AY : **2024-25**

Pre-requisites for the Course:	NIL	
Course Objectives:	This course aims to foster comprehension of the characteristics and behaviour of gases, fundamental principles of thermodynamics, and practical applications in power generation and low-temperature technologies	**No. of Hours**
Content	**Kinetic theory of gases** Three states of matter, concept of ideal gas, postulates of Kinetic Theory of gases, expression of pressure of a gas, relation between rms velocity and temperature, Average kinetic energy of a gas molecule, heat and temperature, kinetic interpretation of temperature, Degrees of freedom, Law of equipartition of energy and its application to specific heats of gases. Brownian motion and its features, Einstein's equation (qualitative), Determination of Avogadro's number. Mean free path and derivation to calculate MFP, Transport phenomena, transport of momentum (viscosity).	**8**
	Behaviour of real gases Deviation from perfect gas behaviour, Discussion of results of Andrew's experiments on CO_2 and Amagat's experiment, critical constants, Van der Wall's equation of state, expression of Wan der Wall's constants, Reduced equation of state, Law of corresponding state, relation between Boyle temperature and critical temperature, critical coefficient.	**7**
	Zeroth and First Law of Thermodynamics Basic concepts of thermodynamics: Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics and concept of temperature, Internal energy and First law of thermodynamics, Relation between pressure, volume and temperature in adiabatic process, Work done in isothermal and adiabatic processes, Path dependence of heat and work.	**5**
	Second and Third Law of Thermodynamics Process-reversible and irreversible, condition of reversibility, Second law of thermodynamics, Carnot's cycle, efficiency of Carnot's cycle, reversibility of Carnot's cycle, Carnot's theorem, coefficient of performance of a refrigerator, Thermodynamic scale of temperature, its identity with perfect gas scale. Entropy as a Thermodynamic variable, Entropy change in reversible and irreversible processes, Temperature–Entropy diagram of Carnot's Cycle, Entropy of a perfect gas, Physical significance of Entropy: Entropy and Unavailable Energy, Entropy and molecular disorder, Entropy and Second Law of	**12**

	Thermodynamics. Impossibility of attaining Absolute Zero, Third law of Thermodynamics	
	Power cycles Internal Combustion Engines – The Otto cycle and its efficiency, Diesel cycle and its efficiency.	**3**
	Production of low temperature. Cooling by evaporation. Vapour compression machines. Refrigerators based on Vapour absorption. Cooling by sudden adiabatic expansion of compressed gases. Efficiency and performance of refrigerating machines. Enthalpy and heat flow. Joule Kelvin effect. Expression for Joule Kelvin coefficient and inversion temperature. Application to Van der Waals' gas. Principles of regenerative and cascade cooling. Liquifaction of hydrogen and helium. Production of temperatures below 4° K. Properties of He I and He II.	**10**
	Practical **Minimum 08 experiments to be performed** 1. To determine temperature coefficient of Pt-100 2. Measurement of thermal conductivity of poor conductors 3. Measurement of thermal conductivity of good conductors 4. Determination of Stefan's constant. 5. Resistance Thermometry Cu wire 6. Thermistor- NTC /PTC 7. Study of thermocouples for temperature measurement 8. Constant volume air thermometer. 9. Constant pressure air thermometer. 10. Calibration of Si diode as a temperature sensor. 11. Specific heat of graphite	**30**
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	Text Books 1. Brij Lal, N. Subrahmanyam and P. S. Hemne, Heat, Thermodynamics and Statistical Physics, S. Chand & Co. (2008) 2. M. W. Zemansky and R.H. Ditman, Heat and Thermodynamics McGraw Hill (2017). 3. Merle C. Potter, Thermal Sciences: An Introduction to Thermodynamics, Fluid Mechanics and Heat Transfer, Cengage Learning India Private Limited, (2015) 4. S. C. Garg, R.M. Bansal and C. K. Ghosh, Thermal Physics, Tata McGraw Hill (2013).	
Course Outcomes:	Student will be able to 1. Recall the fundamental properties of gases and laws of Thermodynamics 2. Understand the principles of heat and thermodynamics. 3. Apply the law to analyse the process. 4. Analyse the factors influencing Behaviour of gas. 5. Examine principles and applications of low-temperature technology.	

GOA UNIVERSITY
गोवा विश्वविद्यालय
Knowledge is Divine

Name of the Program : **B.Sc. Physics**
Course Code : **PHY-202**
Title of the Course : **Electronics**
Number of Credits : **3LT+1P**
Effective from AY : **2024-25**

Prerequisites for the Course	NIL	
Course Objective	This course provides a foundation for understanding and working with electronic components and circuits related to rectifiers, regulators, transistors, amplifiers, biasing, feedback, and linear integrated circuits. The outcomes can be adapted based on the specific focus and depth of the course.	
		No. of hours
Content	**Rectifiers and Regulators** Volt-ampere characteristics of Junction diode, half wave, Full wave and Bridge rectifiers using Junction diodes without and with capacitive filters. Percentage regulation, Ripple factor and Rectification efficiency. Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation	**10**
	Transistors Basic configurations of transistors, Transistor characteristic in CE and CB mode, Current gains α and β and their interrelation, Leakage current in transistors.	**4**
	Basic Amplifier Characteristics Current gain, Voltage gain, Power gain, Input resistance, Output resistance, Conversion efficiency, Classes of amplifier operations, Decibel, Frequency response, Amplifier bandwidth.	**4**
	Transistor Biasing and C-E amplifier: Class A Graphical analysis, Effect of adding A.C. load, Input and Output resistance, Conversion efficiency, Phase relationship between input and output. Bias stability, Stability factor, Different methods of biasing, biasing compensation.	**12**
	Oscillators Positive and negative feedback, Voltage and current feedback, series and shunt feedback. Effect on negative feedback on gain, frequency response, input and output resistance and distortion. Positive feedback, Barkhausen criterion for oscillations, Phase shift oscillator, Wein bridge oscillator, LC tank circuit, Hartley oscillator and Colpitts oscillator.	**9**
	Linear IC's and Operational Amplifiers The Differential Amplifier, OP-Amp characteristics, Input and Output impedance, Input bias and offset currents, Input and output offset voltages. Differential and Common mode gains, CMRR, slew rate, OP-Amp as inverting, non-inverting amplifier, summing amplifier,	**6**

	Difference amplifier, Wein bridge and Phase shift oscillator using Op-Amp.	
	Practical: Minimum 8 experiments 1. Half wave and Full wave rectifier using Junction Diode, Load regulation characteristics. 2. Bridge rectifier with capacitor filter- Ripple factor using CRO. 3. Zener Diode Voltage Regulator. 4. Colpitts / Hartley oscillator using Transistors 5. Wein's Bridge /Phase shift Oscillator using Op-Amp. 6. Input and Output characteristics of transistor in C E mode. 7. C.E. Amplifier. Frequency response with and without negative feedback. Calculation of Gain Bandwidth product. 8. C.E. Amplifier -Variation of Gain with load. 9. OP-Amp: Inverting and Non-inverting amplifier. 10. Inverting adder using Op-Amp. 11. Difference amplifier using Op-Amp.	**30**
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. A.P. Malvino, Electronic Principles Tata McGraw Hill 9th edition (2021) 2. Allen Mottershed, Electronics Devices and Circuits an Introduction- 3rd edition Prentice Hall India (1997) 3. J. Millman and C. C. Halkias, Integrated electronics- Tata McGraw Hill, Yellow edition, (2017). 4. N. N. Bhargava, D. C. Kulshrestha and S. C. Gupta, Basic Electronics and Linear Circuits McGraw Hill, 2nd edition, (2017). 5. Ramakant Gayakwad, Op-amp and Linear Integrated Circuits, Pearson (2015).	
Course Outcomes:	1. Understand the working principles of rectifiers and their applications. 2. Develop a solid understanding of transistor operation and characteristics. 3. Define and explain key amplifier parameters such as gain, bandwidth, and input/output impedance. 4. Understand the characteristics and operation of Class A amplifiers and its stability. 5. Define and explain the concept of feedback in electronic circuits. 6. Understand the characteristics and applications of operational amplifiers (Op-Amps).	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-203**
Title of the Course : **Optics and Modern Physics**
Number of Credits : **3L + 1P**
Effective from AY : **2024-25**

Prerequisites for the Course	NIL	
Course Objectives	This course provides a broad overview of the topics and skills students are expected to gain during their study of interference, diffraction, polarization, atomic physics, properties of electromagnetic radiation, crystal structure, and X-rays.	
Content		**No. of Hours**
	Interference Introduction: Interference by division of wavefront & division of amplitude, Fresnel's biprism and Lloyd's mirror, formation of colours in thin films – reflected system, transmitted system, wedge shaped film, Newton's rings.	**6**
	Diffraction: Concept of diffraction, Fresnel & Fraunhoffer diffraction, division of cylindrical wavefront into half period strips, Fresnel's diffraction at straight edge and cylindrical wire, Fraunhoffer diffraction at single, double and N slits. Diffraction grating, width of principal maxima of plane diffraction grating, resolving power of Optical instruments- Raleigh's criterion, resolving power of telescope, Prism and grating.	**8**
	Polarization: Concept of polarization, plane of polarization, polarization by reflection, Brewster's law, polarization by refraction, double refraction, uniaxial and biaxial crystals, positive and negative crystals, Nicol's prism, Polaroid, retardation plates – Quarter and Half wave plates, optical activity, specific rotation, Laurent's half shade polarimeter.	**8**
	Properties of electromagnetic radiation Black body radiation, Kirchoff's radiation law, Stefan's law, Wein's law, Raleigh-Jean's law, Planck's law. Photoelectric effect and Compton effect- observation, description, derivations of relevant equations and failure of classical physics to explain the same. Experimental verification of the Photoelectric and Compton effects.	**6**
	Atomic Physics Measurement of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph. Review of Bohr's Hydrogen atom, Correction due to finite nuclear mass. Frank-Hertz experiment and atomic energy levels.	**7**
	X-rays Coolidge tube generator, Continuous X-ray spectra and its dependence on voltage, Duane and Hunt's law, Wave nature of X-rays – Laue's pattern, Diffraction of X-rays by crystal, Bragg's law,	**5**

	Bragg single crystal spectrometer, Analysis of crystal structure - simple cubic crystal	
	Crystal Structure Crystal lattice, crystal planes and Miller indices, unit cells, typical crystal structures	**5**
	Practical (Minimum 8 experiments) 1. Searle's goniometer. 2. Cardinal points of lens system 3. Newtons rings: determination of radius of curvature of lens. 4. Single slit diffraction using Na source. 5. Resolving power of telescope using wire mesh. 6. Spectrometer: determination of dispersive power of prism 7. Polarimeter 8. Frank Hertz experiment. 9. Measurement of k/e using transistor. 10. Determination of Planck's constant using LEDs of at least 4 different colours. 11. Photo cell (Verification of Photoelectric effect). 12. Millikan's Oil drop experiment. 13. e/m using Thomson's method.	**[30]**
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	Optics: 1. A. K. Ghatak and K. Thyagarajan: Contemporary Optics, Mc Millan (2020) 2. Ajoy Ghatak, Optics, Tata McGraw-Hill, (2020) 3. B. K. Mathur and T. P. Pandya: Principles of Optics, New Global Printing Press, Kanpur. (1980) 4. Francis A Jenkins and Harvey E White, Fundamentals of Optics, McGraw Hill (2017) Modern Physics: 5. Arthur Beiser, Concepts of Modern Physics, 6th Edition, McGraw Hill (2009) 6. H. Semat and J. R. Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall, 5th edition (1978) 7. J. B. Rajam, Atomic Physics, S. Chand and Co. Ltd. (2023)	
Course Outcomes:	The student will be able to: 1. Analyse the intensity variations of light due to interference, diffraction and polarization. 2. Apply and demonstrate the various phenomena of optics using experimental methods. 3. Understand the fundamental principles of particle acceleration. 4. Explore principles of atomic physics in various scientific disciplines. 5. Discuss application of X-rays in various fields. Discuss the applications of crystallography in in various sciences.	

Name of the Programme : B.Sc. Physics
Course Code : PHY 204
Title of the Course : Classical Mechanics - I
Number of Credits : 3L+1P
Effective from AY : 2024-25

Pre-requisites for the Course:	NIL	
Course Objectives:	This course provides a foundation for understanding classical mechanics and the motion of particles and rigid bodies in different scenarios. They emphasize both theoretical knowledge and problem-solving skills, preparing students for various applications in physics and engineering.	
		No. of Hours
Content	**Motion of a Particle in One and in Two dimensions** Dependence of force in general on position, velocity and time. The equation of motion of particle along straight line. Motion under a constant force with illustrations - Atwood's machine, free fall near the surface of the earth, Motion along a rough inclined plane, motion under a force which depends on time. Motion under a force which depends on time-general approach to the solution. Illustration using force of the type $F = F_o sin(\omega t + \varphi)$. Motion of a particle subjected to a resistive force: Resistive force proportional to first power of velocity, Motion of a particle falling under gravity near the surface of the earth.	**12**
	Projectile Motion Momentum and energy theorem, projectile motion in non-resistive and resistive medium (force proportional to first power of velocity, no derivation).	**5**
	Motion under a central force Central Force, motion in terms of eccentricity (nature of orbits), equivalent one body problem, General features of motion in an arbitrary potential field. Motion in an inverse –square law force field. Equation of the orbit. Kepler's Laws of planetary motion, elliptical orbits.	**10**
	Moving coordinate system Inertial and non- inertial coordinate frames, rotating coordinate systems, laws of motion on the rotating earth, Coriolis force, Foucault's pendulum (no derivation), and Larmor's theorem.	**8**
	Rigid bodies Translation and Rotational motion of a rigid body, Compound pendulum, Location of center of mass relative to the two different origins, theorems to locate the center of mass, Parallel axis and Perpendicular axis theorems. Rotation of a rigid body about an axis, Expression for angular momentum of a rigid body, moment of inertia tensor, Euler's equations of motion of a rigid body, Euler's equation for torque free motion.	**10**
	Practical (Minimum of 8 experiments) 1. Kater's Pendulum.	**[30]**

	2. Investigation of the motion of coupled oscillators. 3. Bar pendulum 4. Y by Koenig's method 5. Y by optical lever 6. Determination of terminal velocity of a body - Stokes method 7. Verification of parallel & perpendicular axis theorem – using Moment of Inertia 8. Determination of Log decrement 9. Determination of viscosity of liquid using log decrement. 10. Inclined plane 11. Projectile motion 12. Acceleration due to gravity by Resonance Pendulum 13. Laws of Gyroscope	
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. A.V. Namjoshi, J. A. Rao, Classical Mechanics Thermal and Statistical Physics (T.Y. B. Sc. Vol. III), Sheth Publishers Pvt. Ltd. (1991). 2. K. R. Symon, Mechanics, 3rd edition, Pearson (2016). 3. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997). 4. S. L. Gupta, V. Kumar and H. V. Sharma, Classical Mechanics, Pragati Prakashan, (2021).	
Course Outcomes:	1. Understand the basic principles of kinematics and dynamics for motion in one and two dimensions. 2. Demonstrate a thorough understanding of projectile motion concepts. 3. Understand the concept of central forces and their implications on the motion of particles. 4. Comprehend the concept of a moving coordinate system and its advantages in problem-solving. 5. Understand the principles of rotational motion and dynamics of rigid bodies.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-205**
Title of the Course : **Mathematical Methods of Physics - I**
Number of Credits : **2L**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of basic mathematics	
Course Objectives:	This course aims to provide the students with the foundation in basic knowledge of Mathematical methods which is required to apply in Physics.	
Content		**No. of Hours**
	Matrices & Determinants Definition and Notations, Addition and Multiplication of Matrices, Properties of Matrix addition and Matrix multiplication, Partition of a Matrix, Rank of a Matrix. Properties of Determinants and Applications	**6**
	Limits, Continuity, and differentiation Algebra of limits, Limits of the trigonometric and exponential function, concept of continuity, left and right-hand limits. Differentiation of first principle, Derivative of polynomials, trigonometric, exponential & logarithmic functions, Rules of differentiation.	**4**
	Integration Integration as inverse process of differentiation, Integration of a variety of functions by substitution, by partial function & by parts. Standard integrals: - Algebraic, trigonometric, exponential and logarithmic.	**4**
	Vector Analysis Addition and Subtraction of Vectors, Multiplication by scalar, Resolution of Vectors, Magnitude of vector, dot & cross product of vectors and their physical interpretation. Directional derivatives, gradient, del operator, Divergence and Curl, Laplacian operator, Integration of a vector function: - line, surface, & volume integral. Gauss divergence theorem (no proof), Stokes theorem (no proof), Differential vector identity. Expression for Laplacian operator in Cartesian, spherical and cylindrical coordinate.	**12**
	Differential Equations Definition of Partial derivative, Total differential chain rule,1st order & 2nd order partial differential equations.	**4**
Pedagogy:	Lectures/ tutorials or a combination of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. B. D. Gupta, Mathematical Physics, S. Chand & Sons (2022) 2. B. S. Rajput, Mathematical Physics, Pragati Prakashan (2023) 3. H.K. Dass & Dr Rama Verma, Mathematical Physics, S. Chand & Co. (2019) 4. P. N. Chatterji, Matrices, Pragati Publication Meerut (2017)	

	5. P. N. Chatterji, Mukesh Gupta and Jyoti Gupta, Integral Calculus, Pragati Publication (2019) 6. Satya Prakash, Mathematical Physics, S. Chand & Sons (2014)
Course Outcomes:	The student will be able to: 1. Explain the properties of Matrices, determinants and discuss its applications. 2. Discuss vector analysis and its applications. 3. Solve problems on limits, continuity and differentiation. 4. Explain and solve the problems on integration and differential equations.

Name of the Program : **B.Sc. Physics**
Course Code : **PHY- 211**
Title of the Course : **Electricity & Magnetism**
Number of Credits : **3L + 1P**
Effective from AY : **2024-25**

Pre-requisites for the Course	Nil	
Course Objective	This course provides a comprehensive overview of the learning outcomes for a course covering circuit analysis, inductance, DC and AC circuits, and the magnetic forces on moving charges and conductors. They serve as a guide for structuring lectures, laboratory work, and assessments in the course.	
Content		**No. of Hours**
	Circuit Analysis Steady current, concept of constant current source and constant voltage source, Maxwells cyclic current method for circuit analysis, Thevenin's theorem, Nortons theorem, Superposition theorem, Maximum power transfer theorem.	**10**
	Inductance Self-inductance, Self-inductance of two parallel wires carrying equal current in opposite directions, Self-inductance of co-axial cables, Mutual inductance, Coefficient of coupling.	**5**
	Response of circuits containing L, C and R to DC Growth and decay of current in L-R circuit, charging and discharging of capacitor in C-R circuit and in a series LCR circuit.	**5**
	A.C. circuits A.C. applied to L-R and C-R circuits, Inductive and Capacitive reactance, Impedance and Admittance, the j operator, AC applied to L-C-R circuits, Series and Parallel resonance. AC applied to mutually coupled L-R circuits, Transformers.	**8**
	Force on a Moving Charge Magnetic induction B and magnetic intensity H, Lorentz force law, Work done by a magnetic field on a moving charge, Force on a moving charge, Magnetic flux.	**5**
	Force on conductor carrying current Force on a conductor carrying current in uniform magnetic field, rectangular current loop in external magnetic field, Dead beat galvanometer, Theory of Ballistic galvanometer.	**6**
	Torque on current loop Torque on a current loop, Magnetic moment of a current loop, Equivalence of current coil to a bar magnet, Magnetic moment of atomic dipole, Angular momentum and gyromagnetic ratio.	**6**
	PRACTICAL (minimum 8 experiments) 1. Verification of Thevenin's theorem 2. Verification of Nortons theorem 3. Step response of RC circuit 4. Response of LR and CR circuits to ac phasor diagrams	**30**

	5. LCR series and parallel resonance - bandwidth, resonant frequency) 6. Electrical stimulation of LR, CR and LCR 7. Resistance of Ballistic/table galvanometer by shunting 8. Magnetic field using Biot - Savart law - number of turns of coil, distance from center of coil 9. Verification of Coulombs law 10. Mapping of magnetic field lines 11. Magnetic field due to a long conductor carrying a current 12. Verification of Ampere circuital law 13. Study of magnetic fields using magnetic sensor	
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. C. L. Arora and P. S. Hemne, Physics for degree students, S. Chand and Company, New Delhi 2nd Revised Edition (2013). 2. D. N. Vasudeva, Fundamentals of Electricity and Magnetism S. Chand and Company, New Delhi (2013) 3. J. Yarwood and J. H. Fewkes, Electricity and Magnetism, University Tutorial Press (1965). 4. Text Book of Electricity and magnetism, Brij Lal and N. Subramanium, Ratan Prakashan Mandir (1966).	
Course Outcomes:	The student will be able to: 1. Understand the basic principles of electric circuits. 2. Understand the behaviour and characteristics of inductors and analyze the role of inductance in electrical circuits. 3. Analyze the response of DC and AC circuits. 4. Understand the Lorentz force acting on a moving charged particle in a magnetic field. 5. Apply the right-hand rule to determine the direction of the force experienced by a current-carrying conductor in a magnetic field. 6. Understand the torque experienced by a current loop in a magnetic field.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY 212**
Title of the Course : **Energy Physics**
Number of Credits : **4L**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims at providing comprehensive understanding of various energy sources and their applications.	
		No. of Hours
Content	**Energy** Energy, efficiency and entropy, entropy and environment, mechanical work- force and energy, energy power and units, kinetic and potential energy, electrical energy, electrical power and transmission, power station capacity, electric motors and generators.	**8**
	Conventional and non-conventional -energy sources Conventional energy sources fossil fuel, hydro -electric, thermal, Nuclear, advantages, disadvantages. Non-conventional Bio-mass, geo-thermal, solar, wind energy, ocean energy, wave energy, advantages and disadvantages.	**8**
	Solar Energy Sun as source of energy, Solar spectrum, sun earth radiation, extra-terrestrial and terrestrial radiation spectral energy distribution of radiation, depletion of solar radiation, pyranometer, sunshine recorder, solar radiation data, solar time.	**8**
	Wind Energy Origin of wind, nature of winds, variation of wind speed with time, wind turbine siting, Types of turbines and their aerodynamics, wind energy conversion system., wind energy storage.	**8**
	Biomass Energy Bio-gas as a source of energy. Benefits of bio-gas. Technology of biogas. Biogas production from waste biomass, Classification of biogas plant, operational parameters of biogas plant.	**8**
	Geothermal Energy Geothermal energy, origin and distribution of geothermal energy, types of geothermal resources. analysis of geothermal resources.	**7**
	Ocean energy Tidal energy, limitations of tidal energy wave energy, ocean thermal energy.	**5**
	Energy storage Flywheel storage, compressed air storage, Battery storage, electrostatic energy storage, thermal energy storage.	**8**
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	Text Books 1. Clare Smith, Environmental Physics, Routledge, Taylor &Francis group (2001)	

	2. B. H. Khan, Non-Conventional Energy Resources, Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi (2009) 3. G. D. Rai, Non-conventional Sources of Energy, Khanna Publishers, Delhi -2008 4. Thomas Ackermann, Wind Power in Power System, John Willey & Sons, (2005) 5. John Twidell & Tony Weir, Renewable Energy Resources, 2 nd Edition, Taylor & Francis (2010) 6. Stephen Peake, Renewable energy; power for a sustainable future, Oxford University Press (2017) 7. Devid M. Buchla, Thomas E. Kissell, Thomas, L. Floyd, Renewable energy systems, Pearson India Education Services Pvt. Ltd. (2017). 8. D. Mukherjee, Fundamentals of Renewable Energy Systems, New Age International Publisher; First edition (2011)
Course Outcomes:	Student will be able to 1. Recall the fundamental concepts of energy. 2. Explain the principles behind energy conversion processes and their efficiency 3. Apply knowledge of energy efficiency principles to real-world scenarios 4. Analyze the environmental impact of various energy production methods.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY 221**
Title of the Course : **Communication Physics**
Number of Credits : **3L+1P**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of Basic Electronics	
Course Objectives:	This course aims at providing an understanding of physics behind various types of electronic communication.	
Content		**No. of Hours**
	Electronic communication: Introduction to communication systems. Need for modulation and frequency allocation for radio communication system. Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.	**5**
	Analog Modulation: Amplitude Modulation, modulation index and frequency spectrum, Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Super heterodyne receiver.	**7**
	Analog Pulse Modulation Channel capacity, Sampling theorem, Basic Principles of PAM, PWM, PPM modulation and detection technique for PAM only, Multiplexing	**4**
	Transmission Lines and Antenna system Introduction, Transmission line, Constants, Characteristic impedance, Propagation constant, Standing waves & SWR. Principles of radiation, Isotropic radiator, Hertzian dipole, Antenna gain, Directivity, Radiation resistance, Wave guides, RADAR	**6**
	Fibre Optics Optical fibres and their properties, Principal of light propagation through a fibre, refractive index profile, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres. Fibre Optic communication- basic principle, Transmission characteristics of optical fibre, attenuation, absorption and scattering losses, nonlinear losses, wavelengths for communication, bend losses, dispersion effects in optical fibres.	**7**
	Digital Communication: Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift	**6**

	Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).	
	Satellite Communication Introduction, Geosynchronous satellite orbits, geostationary satellite, advantages of geostationary satellites. Satellite visibility, ground station, Overview of Indian satellite missions.	**5**
	Cellular Communication Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, authentication of the SIM card of the subscribers, IMEI number, GSM and CDMA technology- an overview, simplified block diagram of cellular phone handset, 2G, 3G,4G and 5G concepts	**5**
	Practical (Minimum 8 experiments) 1. Amplitude modulation and demodulation. 2. To study AM Transmitter and Receiver 3. To study FM Transmitter and Receiver 4. To study Pulse Amplitude Modulation (PAM) 5. To study frequency modulation using phase locked loop circuits. 6. To study Pulse Width Modulation (PWM) 7. To study Pulse Position Modulation (PPM) 8. To study ASK, PSK and FSK modulators 9. Frequency modulation and demodulation. 10. Analog/Digital multiplexer 11. Sample and Hold Circuit. 12. Study of super heterodyne radio receiver. 13. Experiment on Fibre optics communication 14. Design of dipole antenna	**30**
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. Andrea Goldsmith, Wireless communications, Cambridge University Press (2015) 2. B. Grob and M.E. Schultz, Basic Electronics, Mcgraw-Hill (2010). 3. B. P. Pal, Fundamentals of Fibre Optic Telecommunication - Wiley Eastern (1994) 4. B.P. Lathi, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press (2011). 5. D. Roddy and J. Coolen, Electronic Communications, 4th edition Pearson Education India (2008). 6. G. Kennedy, Electronic Communication systems, 3rd edition, Tata McGraw Hill (1999). 7. H. Taub, D. L. Schilling and G. Saha, Principles of Communication Systems, 4th edition Mc-Graw Hill (2017). 8. J. Gowar, Optical Fibre communication systems - Prentice Hall India (1995) 9. J. Palais, Fibre optic communication - Prentice Hall India (1988) 10. L. E. Frenzel, Principles of Electronic communication systems 4th edition, McGraw Hill (2015).	

	11. R. Blake, Electronic Communication system, Cengage, 1st edition (2012). 12. S. Haykin, Communication Systems, Wiley India (2006) 13. S. L. Kakani and Subhra Kakani, Photonics/Optoelectronics, CBS Publishers, (2016). 14. W. Tomasi, Advanced Electronics Communication Systems, 6th edition, Prentice Hall (2015).
Course Outcomes:	Student will be able to 1. Understand basics of electronic communication. 2. Understand Transmission lines and Antenna systems 3. Gain insights about fibre optic communication 4. Appreciate basics of satellite communication 5. Develop conceptual understanding of cellular communication.

Name of the Program : **B.Sc. Physics**
Course Code : **PHY-222**
Title of the Course : **Environmental Physics**
Number of Credits : **4L**
Effective from AY : **2024-25**

Prerequisites for the Course	Basics of heat and thermodynamics	
Course Objective	This course provides a comprehensive overview of the knowledge and skills that students are expected to gain in courses related to environmental physics, heat transfer, atmospheric physics, radiation environment, and nuclear power.	
Content		**No. of Hours**
	Fundamentals of environmental physics Basic concept of light and matter, spectroscopic concepts: introduction to the concept of absorption and emission spectrum and transmission of light, Beer-Lambert law; Scattering of light: Raleigh and Mia scattering, basic concepts of force(action and reaction, friction and air resistance), Gravity: Newtonian gravity and universal gravity, terminal and settling velocity, central forces, Coriolis force, Electric and magnetic field and their forces, earth's magnetic field, electromagnetism in animals and plants.	**15**
	Heat Transfer and Energy Basic laws of thermodynamics; concept of enthalpy, entropy. Heat transfer- conduction, convection and radiation, black body and Planck's constant. Steady state of heat balance of water surfaces, soil and vegetation, steady state heat balance of animals. Heat capacity, latent heat, thermal expansion, heat transmission, heat balance in animals and plants, transmission, absorption and reflection of radiation, atomic absorption and emission spectrometry, biological effects of non-ionising radiation, remote sensing (radiometry, image interpretation). Energy efficiency, Electrical energy, renewable energy, renewable resources – hydro-electric power, wind power, tidal power, wind power, solar power. Energy storage, energy use in transport, energy use in biosphere, biological energy sources.	**20**
	Basic atmospheric physics Atmosphere, General circulation of the atmosphere, Weather disturbances (clouds, tropical cyclones, ocean currents, ozone layer) radiative balance, concept of albedo, solar constant and greenhouse effect, greenhouse gases & greenhouse warming potentials and its impact on climate.	**10**
	Radiation environment: Absorption and emission of radiation, radiance and irradiance, solar radiation, spectrum of solar radiation, attenuation of solar radiation in the atmosphere, radiative properties of natural materials (water, soil, metals and animals), radiation interception by solid structures, plant canopies and animal coats.	**10**

	Nuclear power: Atomic mass and energy, Isotopes, binding energy and mass defects, types of ionising radiation, biological impacts of ionising radiation, radiation dose and dose limits, pathway of radio isotopes and its risk analysis.	**5**
Pedagogy	Lecture sessions shall be interactive in nature to enable peer group learning.	
References & Reading	Text Book 1. Claire Smith, Environmental Physics, Routledge (2001) Reference Books 2. Egbert Boeker and Rienk van Grondelle, Environmental Physics: Sustainable Energy and Climate Change, Wiley 3rd edition (2011) 3. Abel Rodrigues, Raul Albuquerque Sardinha, Gabriel Pita, Fundamental Principles of Environmental Physics, Springer (2021) 4. John L. Monteith and Mike H. Unsworth, Principles of Environmental Physics: Plants, Animals, and the Atmosphere, Elsevier 4th Edition (2014)	
Course Outcomes:	The student will be able to: 1. Gain a foundational understanding of environmental systems and their physical processes. 2. Understand the principles of conduction, convection, and radiation in heat transfer & apply heat transfer equations to real-world scenarios. 3. Understand the role of different atmospheric components. 4. Understand the sources and effects of various types of radiation 5. Explore the use of radiation in various nuclear applications.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-231**
Title of the Course : **Landmark Experiments in Physics**
Number of Credits : **3L**
Effective from AY : **2024-25**

Pre-requisites for the Course:	NIL	
Course Objectives	1. Comprehend how experiments exemplify the inquisitive nature driven by human curiosity. 2. Illustrate how physics has led to modern technology. 3. Explore how physics nurtures curiosity and empowers individuals to create world-changing breakthroughs	
		No. of Hours
Contents	**Cathode Ray Tube: X-rays and the Electron**	**3**
	The Gold Foil Experiment: The Structure of the Atom	**3**
	The Photoelectric Effect: The Light Quantum	**4**
	Cloud Chambers: Cosmic Rays and a Shower of New Particles	**4**
	The First Particle Accelerators: Splitting the Atom	**5**
	Cyclotron: Artificial Production of Radioactivity	**3**
	Synchrotron Radiation: An Unexpected Light Emerges	**3**
	Particle Physics Goes Large: The Strange Resonances	**4**
	Mega-detectors: Finding the Elusive Neutrino	**3**
	Linear Accelerators: The Discovery of Quarks	**3**
	The Tevatron: A Third Generation of Matter	**5**
	The Large Hadron Collider: The Higgs Boson and Beyond	**5**
Pedagogy	Lectures, Regular assessments	
References/Readings:	The Matter of Everything: Twelve Experiments that Changed Our World; Suzie Sheehy; Bloomsbury Publishing PLC (2023)	
Course Outcomes:	1. Recall pivotal experiments, associated scientists, and physics discoveries. 2. Illustrate understanding of experimental methods and their relation to observed phenomena and theories. 3. Develop a scientific mindset by critically evaluating experimental methodologies, and results 4. Appreciate implications of scientific discoveries in technology.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-241**
Title of the Course : **Introduction to LaTeX and open-source plotting software**
Number of Credits : **1L + 2P**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic Knowledge of Computers, Text Editing and Graphs.	
Course Objectives:	This course aims to teach students the fundamentals of scientific writing and document preparation using LaTeX and plotting and analysing experimental data using an open-source software to enable them to create well-referenced, hyperlinked documents that are compatible across platforms.	
		No. of Hours
Content:	**Module 1 (Introduction):** Introduction to LaTeX as a tool for scientific writing, Typing to Typography, Turning Ideas to Inputs.	**2**
	Module 2 (LaTeX Basics): Preparing an Input File, The Inputs – Elements of Sentences and Paragraphs, the document, Sectioning, Preparation and compilation of an article in LaTeX, Declarations, Running LaTeX, Defining Commands and Environments, Figures and Other Floating Bodies, Lining It Up in Columns, Simulating Typed Text.	**3**
	Module 3 (Bibliography): The Table of Contents, Cross-References, Bibliography and Citations (Using BIBTEX, Doing It Yourself), Making an Index or Glossary (Compiling the Entries, Producing an Index or Glossary by Yourself), Keyboard Input and Screen Output, Sending Your Document.	**3**
	Module 4 (Document Classes): Books, Slides, Slides and Overlays, Notes, Printing only some slides and notes, Texts, Letters.	**2**
	Module 5 (Document Formatting): Document and Page Styles, Line and Page Breaking, Numbering, Length, Spaces, and Boxes, Centring and "Flushing", List-Making Environments, Fonts.	**2**
	Module 6 (Open-Source plotting software): Introduction to LabPlot Software, Line Plot, Curve Plot, Scatter Plot, Histogram, Box Plot, Smoothing of Data, Baseline Correction, Curve Fitting to data.	**3**
	Practical Component: **LaTeX** i. Introduction to LaTeX (software's to install Linux/ Windows/ use of Overleaf) and to prepare your own input files for typesetting simple documents. ii. Introducing document classes e.g. article, book, thesis, CV, letter, homework assignment, calendar, poster, presentation etc.	**60**

	iii. Packages, preamble and body of LaTeX using titles, abstract, introduction, chapters, sections, subsections & paragraphs. iv. Figures, tables, references and bibliography, hyperlinked citations & points. v. Manipulating fonts and special characters, expressing mathematical equations and symbols. vi. Pictures and Colors: Pictures, Curves, Grids, Reusing Objects, repeat Patterns, Graphics Package, Colors. vii. Presentations **Lab Plot** i. Importing and Exporting data and use it for • Line Plot • Curve Plot • Scatter Plot • Histogram • Box Plot ii. How To Smooth Your Data in LabPlot. iii. How to perform Baseline Correction. iv. How to Fit a distribution to data. v. How To Plot Functions in LabPlot. vi. How To Fit a Curve in LabPlot.	
Pedagogy:	Lectures, Demonstrations, Laboratory work, use of open-source software's.	
References/ Readings:	1. LaTeX: A document preparation system by Leslie Lamport (2nd edition), Addison-Wesley, New York, 1994. 2. LaTeX quick reference by Mark Gates (https://icl.utk.edu/~mgates3/docs/latex.pdf) 3. LaTeX in 24 Hours, Dilip Datta, 2016, Springer. 4. Learn LaTeX in 30 minutes, https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes 5. Official LaTeX website: https://www.latex-project.org/ 6. https://labplot.kde.org/documentation/ 7. https://www.youtube.com/@LabPlot/videos	
Course Outcomes:	Students will be able to 1. Utilizess LaTeX to prepare a well referenced scientific articles, project reports, presentations and even make conference proceedings. 2. Learn how to use the preamble of a LaTeX file to define document class and layout options, 3. Learn BibTeX to maintain bibliographic information and generate a bibliography for a specific document. 4. Use open-source plotting software and apply it for scientific data plotting and analysis.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-242**
Title of the Course : **Physics using Mathematica**
Number of Credits : **1L + 2P**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of Basic Mathematics, Newtonian Mechanics, Electrostatics	
Course Objectives	1. Understand the fundamental principles of physics and their applications in computational contexts. 2. Learn how to simulate physical phenomena using Mathematica. 3. Develop an appreciation for the power and versatility of Mathematica in the context of physics.	
Content		**No. of Hours**
	Unit 1: Introduction to Mathematica & Mathematics Introduction to Mathematica and it's uses for computation and visualization. Define polynomials, trigonometric functions, radicals, and logarithms. Exploring function properties: zeros, divergence, extrema, and asymptotes. Hyperbolic trigonometric functions and their significance.	**5**
	Unit 2: Newtonian Mechanics Conceptual overview of free fall and projectile motion.	**3**
	Unit 3: Harmonic Oscillations: Overview of simple pendulum, understanding of simple harmonic oscillators and damped harmonic oscillators. Superposition of Harmonic Motions: Superposition of harmonic motions of the same frequencies.	**4**
	Unit 4: Electrostatics Basics Introduction to electrostatics: point charges, divergence, and curl. Understanding equipotential surfaces and their significance.	**3**
	Practical 1. Installation of Wolfram Alpha notebook/Signup to Wolfram cloud (Basic/Free Plan), Notebook and cells, Basic Syntax, Basic Operations. 2. Using Plot, Table and Manipulate. Plotting polynomials (Linear & Quadratic), trigonometric functions, radicals and logarithms. Hyperbolic Trigonometric Functions. Properties of functions (Zero, Divergence, Extrema & Asymptote) 3. Free Fall [with and without air resistance *(first power and second power of velocity*)], 4. Projectile Motion, 5. Simple pendulum, 6. Simple harmonic oscillator, 7. Damped harmonic oscillator. 8. Superposition of two harmonic motions. 9. Lissajous Figures. 10. Vector Plot, Field lines, Equipotential surfaces, dipole.	**60**

Pedagogy	Lectures, Hands-on Sessions on Mathematica/ Wolfram Alpha Notebook Edition. Regular assessments
References/ Readings	1. Boas, Mary L. - Mathematical methods in the physical sciences, 3ed; Wiley 2. Hugh D. Young, Roger A. Freedman - University Physics with Modern Physics in SI Units-Pearson Education Limited (2019). 3. Nino Boccara - Essentials of Mathematica_ With Applications to Mathematics and Physics-Springer (2007) 4. R. Zimmerman, F. Olness - Mathematica for Physics-Addison_Wesley (2002) https://nptel.ac.in/courses/115106121
Course Outcomes	1. Understand the basics of Mathematica programming language, its syntax. 2. Analyze and interpret data from simulations to gain a deeper understanding of physical systems. 3. Synthesize physics concepts and ideas to design and implement solutions to physics problems using Mathematica. 4. Evaluate the effectiveness and appropriateness of Mathematica as a tool for solving physics problems.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY 243**
Title of the Course : **Measurements using Arduino**
Number of Credits : **3**
Effective from AY : **2024-2025**

Pre-requisites for the Course:	Knowledge of basic computer and basic mathematics.	
Course Objectives	1. Understand the fundamental components of an Arduino board 2. Write and implement Arduino code using control statements, functions, and libraries to control electronic component 3. Analyze sensor data and evaluate the data to make informed decisions for various applications	
	Theory (1 Credit)	**No. of Hours**
Content	**Unit1: Introduction** Introduction to Arduino, Features of Arduino, hardware components of Arduino board.	**3**
	Unit 2: Arduino Programming language. Control statements (if, if else, for, while, etc.), operators (Arithmetic, Boolean, etc), functions (Digital I/O, Analog I/O, etc). Libraries.	**3**
	Unit3: Electronics Components Overview of electronics component: Breadboard, Resistors, Potentiometer, Push Button, LEDs (Single and Tricolor LED), LDR, LCD Display, OLED Display, seven segment display, DC Motor.	**4**
	Unit 4: Sensors What are sensors, Working principle of sensors, Examples of sensors: Ultrasonic sensor, IR sensor, Linear Magnetic Hall sensor, Passive IR Sensor, DHT11, Barometer Sensor (BMP180), LDR. Bluetooth Module. Thermocouple Sensor module (max6675).	**5**

	Practical (2 credits) 1. Installation of Arduino software, Connecting Arduino to computer. 2. Writing first Code (Blink LED): Write a program to Blink the in-built LED on the Arduino Board 3. Arduino with Tri colour LED and Push Button: Connect a Tri colour LED to Arduino, write a program to blink LED, use pushbutton to control blinking 4. LCD Interfacing: Connecting 16 x 2 LCD to Arduino, writing a code for displaying text on the LCD. 5. Display Counter using Arduino: Write a program to increase the count whenever the pushbutton is pressed. Display the count on LCD. 6. Seven Segment Display: Connect a Seven Segment Display to Arduino board and write a program to display digits from 0 to 9 on the Seven Segment Display 7. Dot Matrix Display: Connect a 8 x 8 dot matrix Display to Arduino. Write a program to display Alphabets on the dot matrix display. 8. Measurements using Arduino (Minimum **5** from the following) a. Distance Measurement using Ultrasonic sensor. b. Detect the temperature and humidity using DHT11 c. Measurement of unknown Resistance d. Tachometer: IR Sensor Using IR Sensor to measure RPM of simple DC Motor. e. Tachometer: Hall Sensor Using Hall Sensor measure RPM of a pulley, to which a magnet is attached. f. LDR with Arduino g. Motion Sensor Detector using PID h. Barometer (BMP180) Sensor: Temperature, Pressure and Altitude i. Themocouple Sensor(max6675).: j. Temperature in Celsius and Fahrenheit. k. Line Follower Robot Using Arduino.	**60**
Pedagogy	Lectures, Hands-on Sessions on Arduino	
References/Readings:	1. James Arthur, Arduino: The complete guide to Arduino for beginners, including projects, tips, tricks, and programming! 2. Sivakumar Munusami, Arduino Projects: The Complete Beginner's Guide - Explain Step by Step to Arduino Programming 3. Sriram Nagarajan, Arduino: A Complete Guide to Arduino for Beginners including development of 10 Projects 4. https://docs.arduino.cc/learn/starting-guide/whats-arduino 5. https://www.arduino.cc/reference/en/ 6. https://github.com/SriramNagarajan2311?tab=repositories 7. https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English	

	8. https://www.instructables.com/Ultrasonic-Distance-Sensor-Using-Arduino/ 9. https://www.instructables.com/DHT11-Humidity-Sensor-Module-Interface-With-Arduin/ 10. https://www.instructables.com/Arduino-Resistance-Measurement/ 11. https://www.instructables.com/Build-RPM-Meter-With-Arduino-and-IR-Sensor/ 12. https://www.instructables.com/RPM-Measurement-Using-Hall-Sensor-and-Arduino/ 13. https://www.instructables.com/Arduino-LDR-With-LED/ 14. https://www.instructables.com/PIR-Motion-Detector-With-Arduino-simple-and-Easy-D/ 15. https://www.instructables.com/Arduino-and-MAX6675-Thermocouple-Setup-Guide/ 16. https://projecthub.arduino.cc/SurtrTech/bmp280-measure-temperature-pressure-and-altitude-6002cd 17. https://projecthub.arduino.cc/mukeshkp2005/arduino-with-bluetooth-to-control-an-led-a7ad0a 18. https://projecthub.arduino.cc/lightthedreams/line-following-robot-34b1d3
Course Outcomes:	1. Demonstrate Knowledge of Arduino Components. 2. Analyze sensor data collected through Arduino, interpreting it to make informed decisions for various applications. 3. Assess the effectiveness of Arduino-based systems. 4. Create functional Arduino projects exhibiting proficient programming skills and component interfacing.

Semester V & VI
Name of the Program : B.Sc. Physics
Course Code : PHY-300
Title of the Course : Analog and Digital Electronics
Number of Credits : 4L
Effective from AY :

Prerequisites for the Course	Nil	
Course Objective	This course provides a comprehensive framework for the learning outcomes in a course covering electronic devices and circuits, focusing on transistors, multivibrators, FETs, OP-AMPs, voltage regulators, timers, number system logic, flip flops, and counters. They can guide the development of lectures, labs, and assessments for the course.	
		No. of Hours
Content	**Analog Electronics** **Transistors Multivibrator** Transistor as a switch, switching times, Multivibrators – Astable, Monostable, Bistable and Schmitt Trigger.	**6**
	Field Effect Transistors and MOSFETs Basic structure of the JFET, Principles of operation, Characteristic curves and parameters, Common source amplifiers, Common gate amplifier (only qualitative discussion), Depletion type MOSFET and Enhancement type MOSFET, Dual-Gate MOSFET. FET Phase shift oscillator, FET as VVR and its applications in Attenuator, AGC and Voltmeter circuits.	**11**
	Applications of OP-AMP Active diode circuits, Integrator, Differentiator, Comparator, Window comparator, Schmitt Trigger, Waveform generator –Square wave, Triangular and Ramp Generator and monostable.	**6**
	IC Voltage Regulators Fixed voltage regulators using IC-78XX and IC-79XX series, adjustable voltage regulator using IC LM 317.	**3**
	Timers The 555 Timer, Basic concept, 555 block diagram, Monostable, Astable, Bistable and Voltage controlled oscillator (VCO) using 555 timers.	**4**
	Digital Electronics: **Number system Logic.** Binary number system, Binary to Decimal and Decimal to Binary conversion, Basic logic gates, OR, AND, NOR, NAND, and EX-OR, Bubbled OR and Bubbled AND gates. De Morgan's Law's, Boolean Algebra, NAND and NOR gates as universal building blocks in logic circuits, Sum of Products methods and Product of Sum methods of representation of logical functions. Binary addition and Subtraction, Half adder and Full adder, Multiplexer and Demultiplexer. Encoders and decoders	**18**

	Logic families – DTL, TTL Standard TTL NAND gate, Schottky TTL, ECL OR/NOR gate, MOS (inverter, NAND and NOR gates) and CMOS (inverter, NAND and NOR gates).	
	Flip Flops and Counters. Basic RS FF, Clocked RS FF, JK FF, D-type and T-type FF, Master Slave Concept, 3-bit Shift register (shift left, shift right), Applications of FF's in counters, 3 bit count UP/ count DOWN binary ripple counter, Modulus of counter (MOD-3, MOD-5 and MOD-7) BCD Decade Counter, Cascade BCD Decade counters, Principle of digital clock.	**12**
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. A. P. Malvino and Leach, Digital Principles and Applications, TMH (1986) 2. A. P. Malvino, David J. Bates, Patrick E. Hoppe, Electronic Principles: TMH. 9th Edition, (2021) 3. Allen Mottershed, Electronics Devices and Circuits An Introduction: PHI (1997) 4. Dominick Nelson Lobo, Analog and digital electronics, Broadway (2024) 5. R. P. Jain, Modern Digital Electronics, TMH (2003) 6. V. K. Mehta and Rohit Mehta, Principles of Electronics, 12th edition, S. Chand & Company (2020)	
Course Outcomes:	The student will be able to: 1. Understand the principles of multivibrators and their applications. 2. Comprehend the working principles of FET's, understand their biasing and impact on circuit performance. 3. Analyse the operation of IC 555 timers and their & their applications in pulse generators, oscillators. 4. Analyse logic circuits and their truth tables. 5. Understand the concept of flip flops and their applications in sequential logic circuits.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY 301**
Title of the Course : **Atomic and Molecular Physics**
Number of Credits : **4L**
Effective from AY : **2025-26**

Pre-requisites for the Course:	Knowledge of Quantum Mechanics	
Course Objectives:	This course aims at providing an understanding towards the application of quantum mechanics and spectroscopic analyses.	
Content		**No. of Hours**
	Hydrogen Atom Schrodinger's equation for the H-atom, separation of variables, Quantum numbers- *n, l,* m_l, spin, magnetic moment, *J* and m_J,	**7**
	Many Electron Atoms Pauli exclusion principle, Symmetric and Antisymmetric wave functions, Electron configuration, Hund's rule, Spin orbit interaction, Vector atom model, Total angular momentum, L-S coupling, J-J coupling.	**6**
	Atomic Spectra Spectroscopic notation, Alkali metal type spectra, Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra.	**5**
	Atoms in a Magnetic Field Effects of magnetic field on an atom, angular momentum, Magnetic moment and Bohr magnetron, The Stern-Gerlach experiment, Larmor precession, The Normal Zeeman effect, Lande 'g' factor, Zeeman pattern in a weak field (Anomalous Zeeman effect).	**10**
	X-ray Spectra Characteristic spectrum, Moseley's law, Explanation of X-ray spectra on the basis of quantum mechanics, Energy levels and characteristic X-ray lines, X-ray absorption spectra, Fluorescence and Auger effect.	**5**
	Spectra of Diatomic Molecules Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibration-Rotation spectra, Fortrat Parabolas and explanation of band structure on its basis, electronic spectra	**15**
	Raman Effect Raman Effect: Classical and Quantum mechanical explanation, Pure rotational Raman spectra, Vibrational Raman spectra, Rotational fine structure, Experimental set up for Raman spectroscopy.	**12**
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	Text Books 1. Adarsh Shroff, Atomic and Molecular Physics, Sheth Publishers, (2010) 2. Arthur Beiser, Shobhit Mahajan, S Rai Choudhary, Concepts of Modern Physics, 7th Edition, McGraw Hill (2009). 3. Colin Banwell, Fundamentals of Molecular Spectroscopy, TMH (2012) 4. H. Semat and J.R. Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall (1972)	

	5. Raj Kumar, Atomic & Molecular Spectra: Laser, Kedar Nath Ram Nath publisher (2020) 6. S.L. Gupta, V. Kumar, R.C. Sharma, Elements of Spectroscopy, Atomic, Molecular and Laser Physics, Pragati Prakashan, (2016) 7. S.N. Ghoshal, Atomic Physics -Modern Physics, S. Chand (2010) Subramaniyam N., Brijlal, Jivan Seshan, Atomic and Nuclear Physics, S Chand & Company (2007)
Course Outcomes:	Student will be able to 1. Recall Schrödinger's equation, analyze atomic and molecular phenomena. 2. Interpret spectra of atom. 3. Apply quantum mechanics concepts to predict and interpret atomic and molecular behaviours. 4. Analyze atomic and molecular phenomena by applying Schrödinger's equation and using quantum numbers

Name of the Program : **B.Sc. Physics**
Course Code : **PHY-302**
Title of the Course : **Physics Laboratory - I**
Number of Credits : **4P**
Effective from AY : **2025-26**

Prerequisites for the Course	Nil	
Course Objective	This course aims to provide students with a comprehensive understanding of the theoretical concepts and practical aspects associated with each experiment	
		No. of Hours
Content	A minimum of 20 experiments to be performed. 1. Study and analysis transistorized Multivibrators- Astable, Monostable. 2. Study and analysis transistorized Multivibrators- Bistable, Schmitt trigger. 3. F.E.T Characteristics. 4. F.E.T Common Source Amplifier. 5. Verification of De Morgan Law's and Boolean Identities. (Construction using Gates) 6. NAND and NOR gates as universal building blocks. 7. Binary addition- Half adder and Full adder using logic gates. 8. Study of JK flip flop with JK FF IC's as 3-bit Ripple counter. 9. Transient response of L-C-R circuit using square wave generator and CRO. 10. Measurement of Dielectric constant of solids using parallel plate capacitor. 11. Measurement of Hysteresis Loss using CRO. 12. Absolute capacity by Ballistic Galvanometer. 13. Variation of AC resistance of coil with frequency. 14. To determine the value of e/m by Helical method. 15. Balmer series and emission spectra. 16. Absorption spectrum of KMNO4 solution. 17. Resolving fine structure of Sodium D lines using Diffraction(reflection/transmission) grating. 18. Zeeman Effect. 19. Determination of velocity of ultrasonic waves in liquid medium. 20. Energy bandgap of PN junction. 21. Equipotential lines and electric field. 22. Surface tension by Quincke's method. 23. λ by cylindrical obstacle. 24. Determination of Rydberg constant using grating. 25. Study of SISO shift register.	**120**
Pedagogy	Practical sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. C. L. Arora, B.Sc. Practical Physics, S. Chand Publication, (2010)	

	P. S. Bangui, V. V. Pathak, C. G. Patil, T. S. Y. Ram, N. C. Garach: Handbook of Practical Physics, Sheth Publishers Pvt. Ltd. (1992)
Course Outcomes:	The student will be able to: 1. Develop proficiency in using a variety of laboratory instruments and equipment. 2. Acquire skills in collecting and recording experimental data 3. Learn to analyse and interpret experimental results. 4. Gain proficiency in using statistical methods to analyse uncertainties and errors. 5. Learn to identify and troubleshoot experimental issues. Gain familiarity with advanced laboratory instruments and technologies.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-303**
Title of the Course : **Special Theory of Relativity**
Number of Credits : **2L**
Effective from AY : **2025-26**

Prerequisites for the Course	Nil	
Course Objective	This course provides a foundation for students to grasp the experimental and theoretical aspects of special relativity, including kinematics, dynamics, spacetime geometry, and an introduction to the broader concepts of general relativity.	
		No. of Hours
Content	**Introduction to Theory of Special Relativity** Galilean Transformations, Newtonian Relativity, Michelson Morley Experiment, attempts to preserve the concept of a preferred Ether frame, (Lorentz-Fitzgerald Hypothesis), Einstein's Postulates of Special Relativity.	**7**
	Relativistic Kinematics Relativity of Simultaneity, Derivation of the Lorentz Transformations and derivation of its consequences such as Length Contraction and Time dilation, Relativistic addition of velocities, Relativistic Transformation of velocities Aberration and Doppler Effect.	**7**
	Relativistic Dynamics Dynamics and relativity, need to redefine momentum, Relativistic Momentum, Relativistic Force law, and dynamics of a single particle, Longitudinal and transverse mass, Equivalence of mass and energy $E= Mc^2$, Lorentz transformation of Momentum, Energy, Mass and Force,	**10**
	Geometric Representation of Space-Time, The Twin Paradox (Qualitative Approach). Principle of Equivalence and General Theory of Relativity (Introduction)	**6**
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. N.C. Garach, Understanding Relativity, Vol. I, Sheth Publishers (1994). 2. Norman Gray, A Student's Guide to Special Relativity, Cambridge University Press (2022) 3. Robert Resnik, Introduction to Special Relativity Wiley (1968). 4. Sriranjan Banerji and Asit Banerjee, The Special Theory of Relativity, 2nd Edition, Prentice Hall India Limited (2012)	
Course Outcomes:	The student will be able to: 1. Understand the historical context and experimental observations that led to the development of special relativity. 2. Develop a deep understanding of Lorentz transformations and apply relativistic kinematics to describe time dilation and length contraction. 3. Understand the concept of relativistic mass and its implications 4. Apply spacetime diagrams to visualize relativistic effects	

	5. Analyse the Twin Paradox qualitatively using time dilation and relativistic effects 6. Understand the principle of equivalence and its role in the development of general relativity.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-304**
Title of the Course : **Electromagnetic Theory**
Number of Credits : **4L**
Effective from AY : **2025-26**

Prerequisites for the Course	Basic knowledge about electricity and magnetism	
Course Objective	This course covers a comprehensive range of topics in electromagnetism, providing students with a solid understanding of the principles and applications in this field.	
		No. of Hours
Content	**Electrostatics** Coulomb's Law, Electric Field and electrostatic potential, Continuous Charge distribution, field lines, flux and Gauss' law with applications, the electric dipole- field and potential.	**6**
	Techniques to solve electrostatic problems The electrostatic potential, Poisson's equation, Laplace's equation, Laplace's equation in one independent variable, solutions to Laplace's equation in spherical co-ordinates (zonal harmonics), conducting sphere in a uniform electric field	**6**
	Electric Fields in matter Polarization, Fields outside a dielectric medium, electric field inside a dielectric, Gauss's law in a dielectric, the electric displacement vector, electric susceptibility, dielectric constant and their constitutive relations. Boundary conditions on the field vectors, Dielectric sphere in a uniform electric field.	**6**
	Microscopic Theory of Dielectrics Molecular field in a dielectric, induced dipoles, A simple model, polar molecules, Langevin- Debye formula, permanent polarization, ferroelectricity.	**5**
	Work and Energy in electrostatics Work and Potential energy of discrete and continuous charge distributions, Energy density of an electric field.	**5**
	Steady currents and their magnetic fields Steady currents, current density, Biot-Savart's law and its applications, Ampere's circuital law, magnetic vector potential, magnetic field of a distant circuit, magnetic dipoles, dipole moment and the field of a point magnetic dipole, magnetic scalar potential.	**8**
	Magnetic Field in material media Magnetization, magnetic field produced by magnetized material, magnetic pole density, sources of the magnetic field, magnetic intensity H (Auxiliary magnetic field), The field equations, magnetic susceptibility and permeability, Hysteresis, Boundary conditions on **B** and **H** vectors, Magnetic circuits,	**10**
	Microscopic Theory of Magnetism Molecular field inside matter, Brief discussion on different classes of magnetic materials, Ferromagnetic domains	**4**

	Magnetic Energy Magnetic energy of coupled circuits, Energy density in the magnetic field, Hysteresis Loss.	**3**
	Maxwell's Equations Faraday's Law of electromagnetic induction, Generalization of Ampere's Law- Displacement current, Maxwell's equations and their empirical basis, Electromagnetic energy-Poyntings theorem. General equation of plane electromagnetic waves.	**7**
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. J. R. Reitz, F. J.Milford and R. W. Christy, Foundations of Electromagnetic Theory, 4th Edition, Pearson/Addision- Wesley Publishing Company. (2009) 2. David Griffiths, Introduction to Electrodynamics, Prentice Hall of India Ltd, New Delhi (1995) 3. A. S. Mahajan and A. A. Rangawala, Electricity and Magnetism, Tata McGraw-Hill Publishing Company Ltd., (2017). 4. D. Chattopadhay and P. C. Rakshit, Electricity and Magnetism, 9th Edition, New Central Book Agency, (2011)	
Course Outcomes:	The student will be able to: 1. Understand the fundamental principles of electrostatics. 2. Develop problem-solving skills for various electrostatic scenarios. 3. Understand the macroscopic and microscopic response of materials to electric fields. 4. Calculate work done in various electrostatic scenarios. 5. Analyse the behaviour of magnetic fields in different materials. 6. Familiarize with Maxwell's equations & their significance.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-305**
Title of the Course : **Quantum Mechanics - I**
Number of Credits : **4L**
Effective from AY : **2025-26**

Prerequisites for the Course	Knowledge of basic mathematics and Modern Physics	
Course Objective	This course provides a foundation for understanding the key principles and concepts in quantum mechanics, starting from its historical development to the mathematical formulation and its applications. The outcomes focus on developing both theoretical understanding and problem-solving skills in the context of quantum theory.	
		No. of Hours
Content	**Origin of the Quantum theory** Limitations of classical Physics to explain the phenomenon such as black body spectrum and photoelectric effect, De Broglie's hypothesis, Review of the Bohr's postulates about stationary states. The concept of quantum (particle) nature of radiation. Demonstration of wave nature of particles-Davisson Germer experiment, electron diffraction experiment of G.P. Thomson, Dual nature of radiation/matter. Complimentary in Duality.	**10**
	The Wave Function Representation of a De Broglie wave, Velocity of De Broglie wave, Construction of a wave group, Wave packet and its motion in one dimension., Group velocity and particle velocity, Max Born's interpretation of the wave function, probability concept, Acceptable wave function, Normalization of wave function.	**6**
	Heisenberg's Uncertainty Principle Limitation of wave mechanics to predict the physical state of a particle/system accurately. Heisenberg Uncertainty principle Illustration by thought experiments (γ - ray microscope, single slit diffraction and double slit experiment), Applications of Heisenberg Uncertainty principle.	**8**
	Schrodinger's Wave Equation Wave equation for De Broglie waves and Schrodinger's time dependent wave equation, Concept of stationary states. Schrodinger's time independent equation. Postulates of Quantum mechanics, Definition of operators, angular momentum operator, Lagrangian and Hamiltonian operators, parity operator, Expectation values, Extraction of information from solutions in terms of expectation values of physical variables/observable. Eigen value equation, Commutation relations.	**16**
	Applications of Schrödinger's Time Independent Wave Equation Free particle, Infinite square well potential (particle in a one-dimensional box): Energy eigen functions and eigen values, Expression for <x> and <p>. Particle in a three-dimensional box, Concept of degeneracy. One dimensional step potential of height	**20**

	Vo: Comparison of classical and quantum mechanical results for a particle energy with E > Vo and E < Vo, Rectangular potential barrier of finite height and penetration through it, tunnel effect, Qualitative discussion of alpha decay, tunnel diode & scanning tunnelling microscope. Particle in a symmetric potential well.	
Pedagogy	Lectures/tutorials or a combination of these. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. A. Ghatak and S. Lokanathan, Quantum Mechanics, Theory and Applications, Mc Millan (2004). 2. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1995). 3. Arthur Beiser, Perspectives of Modern Physics, 5th Edition, McGraw Hill (1995). 4. C. L. Arora, Refresher course in Physics, Volume II, S. Chand (2022) 5. F.K. Richtmayer, E. H. Kennard, J.N. Cooper, Introduction to Modern Physics (1969). 6. K.G. Bhole, Abhay Ranade, Adarsh Shroff, New Course in Physics, Volume II, Sheth Publishers, (2022)	
Course Outcomes:	The student will be able to: 1. Understand the historical development and key contributors to the quantum theory. 2. Define and understand the concept of the wave function in quantum mechanics 3. State Heisenberg's Uncertainty Principle and understand its implications. 4. Derive and understand Schrödinger's time-independent wave equation. 5. Apply Schrödinger's time-independent wave equation to solve problems in quantum mechanics.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-306**
Title of the Course : **Physics Laboratory - II**
Number of Credits : **4P**
Effective from AY : **2025-26**

Prerequisites for the Course	Nil	
Course Objective	This course aims to provide students with a comprehensive understanding of the theoretical concepts and practical aspects associated with each experiment	
		No. of Hours
Content	[A minimum of 20 experiments are to be performed] 1. Op-Amp as square wave generator 2. Op-Amp as Integrator/Differentiator. 3. Regulated power supply using IC LM 317 with external pass transistor. 4. Study of IC 555 Timer as Astable multivibrator & VCO. 5. Study of IC 555 Timer as Monostable multivibrator. 6. Digital Multiplexer (4 to 1 line). 7. Digital Demultiplexer (1 to 4 line). 8. Decade counter using JK Flip flop and IC 7490. 9. Copper and Core losses in transformers. 10. Mutual inductance using Ballistic galvanometer, 11. Determination of Cauchy's constant A and B. 12. Study of Hall effect. 13. Mutually coupled tuned series LCR circuits. 14. Hysteresis by Magnetometer. 15. C1/C2 by De Sauty method. 16. Magnetic susceptibility of paramagnetic substances by Guoy's Balance. 17. Determination of Dielectric constant and susceptibility for liquid medium. 18. Double refraction. 19. Resolving power of grating. 20. Helmholtz coil and measurement of Faraday's number. 21. Dielectric constant and susceptibility of solid using series resonance method. 22. BCD Encoder. 23. Op-Amp as window comparator. 24. Fresnel Biprism. 25. Estimation of Reynolds number.	**120**
Pedagogy	Practical sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. C. L. Arora, B.Sc. Practical Physics, S. Chand Publication, (2010) 2. P. S. Bangui, V. V. Pathak, C. G. Patil, T. S. Y. Ram, N. C. Garach: Handbook of Practical Physics, Sheth Publishers Pvt. Ltd. (1992)	

Course Outcomes:	The student will be able to: 1. Develop proficiency in using a variety of laboratory instruments and equipment. 2. Acquire skills in collecting and recording experimental data 3. Learn to analyse and interpret experimental results. 4. Gain proficiency in using statistical methods to analyse uncertainties and errors. 5. Learn to identify and troubleshoot experimental issues. 6. Gain familiarity with advanced laboratory instruments and technologies.

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY-321**
Title of the Course : **Experimental Physics**
Number of Credits : **3L + 1P**
Effective from AY : **2024-25**

Prerequisites for the Course	Nil	
Course Objective	This course provides a comprehensive overview of the skills and knowledge that students are expected to gain related to physical measurement, laboratory instruments, experimental methods, experimental logic, and signal-to-noise considerations in measurement systems.	
		No. of Hours
Content	**Physical measurement:** Measurement, The result of a measurement, Sources of uncertainty, Experimental errors, Types of error- Systematic & random, Common sense in errors, Definition of uncertainty, The analysis of repeated measurements, Mathematical description of data and distribution function, properties of distribution functions, Propagation of error, Analysis of data, multi-parameter experiments.	**11**
	Laboratory instruments and experimental methods: Meter ruler, vernier callipers & micrometre screw gauge (choice of method), Temperature effect on length measurement, beat method of measuring frequency, negative feed-back amplifier, servo systems, natural limit for measurement, Experiment design, Choice of transducers, Modelling external circuit components and circuit calculations, Instrument probes, power measurements, DC & AC bridge measurements, Measurement methods.	**12**
	Experimental logic: Cause of experimental mistakes, Apparent symmetry in apparatus, sequence of measurements, intentional & unintentional changes, drift, systematic variations, Calculated and empirical corrections, Need for precise measurements, Experimental common sense.	**10**
	Signal to noise considerations in measurement system: Fluctuations & noise, noise in frequency domain, sources of noise, signal to noise & experimental design, Frequency & band width considerations, band width control, signal to noise enhancement – Phase sensitive lock-in amplification & detection, digital & auto correlation methods, Frequency measurements using Fourier analysis and Fast Fourier transform.	**12**
	Practical Students are expected to design & perform at least six experiments from the following list. 1. Measurement of resistance and error up to 10 ohms. 2. Measurement of acceleration due to gravity and errors using simple pendulum and bar pendulum. 3. Measurement of frequency and error using CRO and DSO 4. Measurement of Stefan's constant	**30**

	5. Measurement of Seebeck coefficient 6. Measurement of temperature and errors using thermocouple, thermistor and temperature sensor LM 35. 7. Measurement of length and errors using metre scale, vernier calliper and traveling microscope. 8. Measurement of Inductance and errors using LCR meter and bridge circuit. 9. Measurement of capacitance and errors using LCR meter and bridge circuit/oscillator circuit.	
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. Ifan G. Hughes & Thomas P.A. Hase, Measurements and their uncertainties: a practical guide to modern error analysis, Oxford, (2010) 2. Measurement Instrumentation & Experiment Design in Physics & Engineering, Michael Sayer & Abhay Mansingh, PHI publications (1999) 3. Physics by G. L. Squires, Cambridge University Press ,4th Edition, (2014)	
Course Outcomes:	The student will be able to: 1. Demonstrate a thorough understanding of fundamental concepts and principles in physical measurement. 2. Understand the functioning and limitations of different instruments & design experimental setups for specific measurements. 3. Design experiments based on the principles of experimental logic. 4. Differentiate between signal and noise in a measurement system & Identify source of noise in measurement systems. 5. Apply signal-to-noise considerations in practical applications & understand the impact of signal-to-noise ratios on measurement accuracy.	

Name of the Program : **B.Sc. Physics**
Course Code : **PHY-322**
Title of the Course : **Biomedical Instrumentation**
Number of Credits : **4L**
Effective from AY : **2025-26**

Prerequisites for the Course	NIL	
Course Objective	The objective of this course is to illustrate origin of bio potentials and its propagations, understand the different type of electrodes and its placement for various recordings, design bio amplifier for various physiological recordings, learn the different measurement techniques for no-physiological parameters and summarize different biochemical measurements.	
		No. of Hours
Content	**Biopotential electrodes:** Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode-skin interface, half-cell potential, contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes – surface, needle and micro electrodes and their equivalent circuits. Recording problems-motion artifacts, measurement with two electrodes.	**12**
	Biopotential measurements: Bio signals characteristics – frequency and amplitude ranges. ECG- Einthoven's triangle, standard 12 lead system, Principles of vector cardiography. EEG- 10-20 electrode system, unipolar, bipolar and average mode. EMG – unipolar and bipolar mode.	**12**
	Signal conditioning circuits: Need for bio-amplifier – single ended bio-amplifier, differential bio-amplifier, impedance matching circuit, isolation amplifiers – transformer and optical isolation- isolated DC amplifier and AC carrier amplifier. Power line interference, Right leg driven ECG amplifier, Band pass filtering.	**12**
	Measurement of non-electrical parameters: Temperature, respiration rate and pulse rate measurements. Blood pressure: indirect methods- Auscultatory method, oscillometric method, direct methods: electronic manometer, pressure amplifiers, systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution method, Electromagnetic and ultrasound blood flow measurement.	**12**
	Biochemical measurement and biosensors: Biochemical sensors = pH, pO2 and pCO2, Ion selective field effect transistor (ISFET), Immunologically sensitive FET(IMFET), Blood glucose sensors, Blood gas analyzers – colorimeter, Sodium Potassium Analyser, Spectrophotometer, blood cell counter, auto	**12**

	analyzer (simplified schematic description)- Bio sensors- Principles – amperometric and voltometric techniques.	
Pedagogy	Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	1. Leslie Cromwell – Biomedical Instrumentation and measurement, 2nd edition, Prentice Hall of India, New Delhi, 2015. 2. Khandpur R.S. – Handbook of Biomedical Instrumentation, 3rd edition, Tata McGraw-Hill, New Delhi, 2014. 3. John G, Webster – Medical Instrumentation- Application and Design, 4th edition, Wiley India Pvt. Ltd, New Delhi, 2015. 4. Joseph J. Carr and John M. Brown – Introduction to Biomedical Equipment Technology, Pearson Education, 2004.	
Course Outcomes:	The student will be able to: 1. Differentiate different bio potentials and its propagations. 2. Illustrate different electrode placement for various physiological recordings. 3. Design bio amplifier for various physiological recordings. 4. Explain various technique for non-electrical physiological measurements. 5. Demonstrate different biochemical measurement techniques.	

Name of the Programme : **B.Sc. Physics**
Course Code : **PHY 323**
Title of the Course : **Nuclear Reactor and Accelerator Physics**
Number of Credits : **4L**
Effective from AY :

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims at providing an understanding of the principles, working, safety and applications of nuclear reactors and particle accelerators.	
		No. of Hours
Content	**Radioactivity** Radioactivity, law of radioactive decay; Derivation of expression for exponential decay, half & mean life, Successive radioactive transformation (A→B→C type); ideal, transient, and secular equilibrium; radioactive series; Radioactive-carbon dating.	**8**
	Nuclear Reactions Compound nucleus, Energetics of nuclear reactions, Q value, threshold energy of endoergic reactions, Discovery of neutron, Determination of neutron mass.	**8**
	Radioactive Decay Alpha decay: Alpha disintegration energy; Geiger-Nuttal law, short range and long-range alpha particles; Gamow theory of alpha decay (qualitative treatment); Beta decay: Types of beta decay; energies of beta decay; the continuous beta particle spectrum; difficulties in understanding the spectrum; Pauli's neutrino hypothesis; K capture Gamma decay: Origin of the decay; internal conversion and nuclear isomerism.	**9**
	Nuclear Power generation Neutron induced fission; chain reaction; mass yield in an asymmetrical fission; neutron cycle in a thermal nuclear reactor (the four factor formula) breeder reactor, structure of nuclear reactor and it's working principle,Nuclear power plant and their classification-Light water reactor, pressurised water reactor, fast neutron reactor	**12**
	Particle Accelerators Linear accelerators (LINAC), Cyclotron, synchrotrons.	**5**
	Nuclear detectors Non-imaging -ionisation detectors: Ionization chamber; proportional chamber; Geiger Muller counter; Scintillation detectors, semiconductor detector. Imaging detectors - Gamma camera, Positron emission tomography (PET) system	**12**
	Nuclear safety Radiation effects on human body, radiation protection principles, nuclear safety and security, safety goals and culture.	**6**
Pedagogy:	Lectures/ tutorials or a combination of these and Laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	

References/ Readings:	1. S.B. Patel, Nuclear Physics, New Age International Pvt Ltd Publishers (2011). 2. Jacques Libmann, Elements of Nuclear Safety, EDP Science, (2000) 3. Arthur Beiser, Shobhit Mahajan, S Rai Choudhary, Concepts of Modern Physics, 7th Edition, McGraw Hill (2009). 4. D. L. Bailey, J. L. Humm, A. Todd-Pokropek, A.Van Aswegen, Nuclear Medicine Physics-A handbook for teachers and students, International Atomic Agency, (2014). 5. B. Zohuri, and P. McDaniel, Nuclear Power Plants - Thermodynamics In Nuclear Power Plant Systems second edition, Springer (2015) 6. A. Das, T. Ferbel, Introduction to Nuclear Physics,2nd Edition, World Scientific (2005). 7. Irving Kaplan, Nuclear Physics, Narosa Publishing House (2002). 8. F.K. Richtmyer, E.H. Kennord, J.N. Cooper, Introduction to Modern Physics, (6th Ed.) McGraw Hill (1997). 9. K. Ilangovan, Nuclear Physics, MJP publishers (2021).
Course Outcomes:	Student will be able to 1. Recall decay laws related to nuclear Physics 2. Interpret nuclear reactions and decay outcomes, 3. Discuss ethical dimensions in nuclear science 4. Apply the understanding gained to predict energetics, address real world problem, implement effective safety protocol. 5. Analyse nuclear reactions, decay processes 6. Evaluate the environmental impact of nuclear activities

Name of the Program : **B.Sc. Physics**
Course Code : **PHY-324**
Title of the Course : **Solid State Devices & Instrumentation**
Number of Credits : **4L**
Effective from AY : **2025-26**

Prerequisites for the Course	Nil	
Course Objectives	This course provides an understanding of the working and applications of various solid-state devices and instrumentation used in laboratory and industries.	
Content		**No. of Hours**
	Two Terminal Devices Power diodes, Tunnel diodes, Varicap diodes, Schottky Barrier diode, Semiconductor photoconductive cell, Photovoltaic cell, Photodiode, Phototransistor, Light emitting diodes (LED), Liquid Crystal display (LCD), Solar cells and Photocouplers.	**6**
	Industrial Devices Silicon controlled rectifier (SCR), SCR characteristics, rating, construction and terminal identification, SCR applications, Silicon controlled switch (SCS), Gate turn off switch (GTO), Light activated SCR (LASCR), Shockley diode, Diac, Triac, Typical Diac-Triac Phase control circuit, Unijunction transistor (UJT).	**10**
	Measuring Instruments Errors in measurement, Basic PMMC, Analog DC ammeter, Multirange ammeter, Universal shunt, AC & DC voltmeter, Multirange voltmeter, Extending voltmeter range, Transistor voltmeter, Ohmmeter – Series and shunt type, Digital Multimeter, Digital voltmeter (RAMP type), Resolution and sensitivity of digital meters, frequency meter and Q meter.	**12**
	Oscilloscope CRT, CRO block diagram (simple CRO), Vertical amplifier, horizontal deflection system, sweep generator, Delay line.	**3**
	Transducers Introduction, Electrical transducer, selecting a transducer, Resistive transducer, Strain gauges -wire strain gauge, metal foil strain gauge, semiconductor strain gauge, Thermistor, Inductive transducer, LVDT, Capacitive transducer, Piezo electric transducer and Hall effect transducers.	**10**
	Signal Generator Standard signal generator, AF sine and square wave generator, Function generator.	**4**
Pedagogy	Lectures/tutorials or a combination of these & laboratory practical. Sessions shall be interactive in nature to enable peer group learning.	
References & Reading	**Solid State Devices:** 1. A. P. Malvino, Electronic Principles, Tata McGraw Hill (2007) 2. Allen Mottershed, Electronic Devices and Circuits: An Introduction: PHI (1997)	

	3. J. Millman and C. Halkias, Electronic Devices and Circuits, McGraw Hill (1972) 4. R. R. Gulati Monochrome and Colour TV, 2nd Ed., New Age International, 2005 5. Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11t Ed. PHI (2009) **Instrumentation:** 6. A. K. Sawhney: A course in Electrical and Electronic Measurement, Dhanpat Rai and Co. (2001) 7. H. S. Kalsi, Electronic Instrumentation: Tata McGraw Hill (2004) 8. William David Cooper, Electronic Instrumentation and Measurement Techniques, PHI (2003)
Course Outcomes:	The student will be able to: 1. Understand the principles and functionality of different two terminal devices. 2. Gain a comprehensive understanding of industrial devices and their applications. 3. Develop proficiency in the use of various measuring instruments for electrical and electronic parameters. 4. Understand the basic principles of operation of an oscilloscope. 5. Analyse the characteristics and performance of various transducers. 6. Analyse and interpret signals generated by signal generators.

Semester VII & VIII
Name of the Programme : B.Sc. (Physics)
Course Code : PHY - 400
Title of the Course : Mathematical Physics - II
Number of Credits : 4L
Effective from AY : 2024-25

Prerequisites for the course:	Should have studied the courses in Physics at graduation level.	
Course Objectives:	Students will get exposed to necessary mathematical skills that are essential to understand different phenomena in physics. The course also helps students to understand the theoretical background of other core courses in physics.	
Content:		**No. of Hours**
	Ordinary Differential Equations Second order homogeneous and inhomogeneous equation, Wronskian, General Solutions, Ordinary and Singular points, Series Solutions. Polynomial solutions, Legendre's equation, Bessel's equation, Gamma function	**14**
	Functions of Complex Variable Limits, Continuity, Analyticity of Functions of a Complex Variable, Taylor and Laurent Series, Isolated and Essential Singularities, Branch Cuts, Cauchy Formula, Contour Integration, Application of Residue Theorem.	**15**
	Linear Vector Spaces Linear Operators, Matrices, Coordinate Transformations, Eigenvalue Problems, Diagonalization of Matrices, Infinite Dimensional Spaces, Elements of Group Theory.	**9**
	Integral Transforms Fourier Series, Fourier Transforms, Laplace Transforms, Applications of Integral Transforms.	**12**
	Boundary Value and Initial Value Problems Vibrating String in one Dimension, Heat Conduction, and Wave Equation.	**10**
Pedagogy:	Lectures/ tutorials or a combination of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings:	1. Charlie Harper, Introduction to Mathematical Physics, PHI. D. Van Nostrand Company Ltd (2004). 2. George B. Arfken and Hans J. Weber, Mathematical methods for Physicists, 7/e Elsevier Inc., 2012. 3. J. Mathew and R. L. Walker, Mathematical Methods for Physics, Benjamin Publishers (1973). 4. James W. Brown and R. V. Churchill Complex Variables and Applications, 6th Edition (international), McGraw - Hill (1996**).** 5. K.F. Riley, M.P. Hobson and S.J. Bence, Mathematical Methods for Physics and engineering, Cambridge University Press, Cambridge UK (Reprint 2002)	

	6. L. A. Pipes, Applied Mathematics for Engineers and Physicists, 3rd Edition, McGraw-Hill (1971). Mathematics for Engineers and Scientists by (Schaum's series) (1980). 7. Murray R. Spiegel, Theory and problems in Complex Variables by (Schaum' series) (2009). 8. Murray R. Spiegel, Theory and problems of advanced W. W. Bell, Special Functions for Scientists and Engineers,
Course Outcomes:	Students will be able to 1. Analyze the necessary mathematical concepts. 2. Demonstrate proficiency in mathematical skills required for a master's in Physics. 3. Apply the mathematical skills in other courses of Physics. 4. Evaluate the mathematical background of various concepts in physics.

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-401**
Title of the Course : **Classical Mechanics - II**
Number of Credits : **4L**
Effective from AY : **2024-25**

Pre-requisites for the course:	Should have studied basic courses in mechanics in B.Sc. and Mathematics.	
Course Objectives:	This course is aimed at understanding intermediate to advanced classical mechanics and to build the necessary framework for other topics that requires classical mechanics such as quantum mechanics, statistical mechanics and electromagnetism.	
		No. of Hours
Content:	**Newton's Laws of Motion** Mechanics of a single particle, Mechanics of a system particles, Constraints and their classification, Principle of virtual work, D'Alembert's principle.	**6**
	Lagrangian Formulation Degrees of Freedom, Generalized Coordinates, Calculus of variations, Hamilton's principle, Euler-Lagrange's equations of motion, Application to non-holonomic systems, Advantages of a variational principle formulation, Conservation theorems and symmetry properties.	**10**
	Rigid Body Dynamics Eulerian angles, Inertia tensor, Angular momentum of rigid body. Free motion of rigid body, Motion of symmetric top.	**8**
	Hamilton's equation of motion Legendre transformation and the Hamilton equations of motion, cyclic coordinates and conservation theorems, Routh's procedure and oscillation about steady motion, Derivation of Hamilton's equations from a variational principle, Principle of least action.	**10**
	Canonical Transformations Equations of canonical transformations, Examples of canonical transformations, Poisson brackets and other canonical invariants, Equations of motion, Infinitesimal canonical transformation theorems in Poisson bracket formulation, Angular momentum, Poisson brackets relations, Lagrange brackets.	**8**
	Hamilton - Jacobi Theory H-J equation for Hamilton's principal function, Harmonic oscillator problems, H -J equation for characteristic function, Action angle, Kepler's problem.	**6**
	Two-body Central Force Problem Equations of motion and first integrals, Classification of orbits, virial theorem, Differential equation and integrable power law potentials, Kepler's problem.	**7**
	Small Oscillations Simple Harmonic Oscillations, Damped Oscillations, Forced Oscillations without and with damping, Coupled Oscillations.	**5**

Pedagogy:	Lectures/ tutorials/ assignments. Sessions shall be interactive in nature to enable peer group learning.
References/ Readings	1. H. Goldstein, Classical Mechanics. McMillan, Bombay, 1998. 2. J. C. Upadhyaya, Classical Mechanics. Himalaya, Publishing House, Mumbai, 1991. 3. M. G. Calkin, Lagrangian and Hamiltonian Mechanics. World Scientific, 1996. 4. N. C. Rana, and P. S. Joag, Classical Mechanics. Tata Mcgraw-Hill, 1991. 5. P. V. Panat, Classical Mechanics. Alpha Science International Ltd, 2004.
Course Outcomes:	Students will be able to 1. Apply the principles of Lagrange-Hamilton formalism to classify and explain the motion of a mechanical system. 2. Create equations of motion for complex mechanical systems in classical mechanics by applying the formalism of Lagrangian and Hamiltonian. 3. Analyze the differential equations of orbit and determine the stability of the orbit under central force. 4. Evaluate and contrast the differences between Lagrangian and Hamiltonian formalism, Galilean and Lorentz transformation, and various reference frames.

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-402**
Title of the Course : **Electrodynamics**
Number of Credits : **4L**
Effective from AY : **2024-25**

Pre-requisites for the course:	Should have studied electrostatics and magnetostatics at the graduation level.	
Course Objectives:	The aim of this course is to develop understanding of time varying scalar and vector electromagnetic fields and relativity. To inculcate fundamental concepts related to electromagnetic waves, their transmission via wave guides, radiation and plasma.	
Content:		**No. of Hours**
	Maxwells Equations: Displacement current, Maxwell's equations, Vector and Scalar potentials, Gauge transformation, Lorentz and Coulomb gauge, Poynting's theorem, Conservation of energy and momentum for charged particles and fields.	**10**
	Electromagnetic Waves Plane electromagnetic waves and their propagation in non- conducting and conducting media, Frequency dispersion in conductors	**9**
	Electromagnetic Radiation Retarded Potentials, Fields and radiation by localized dipole, Lienerd Weichert potentials, Power radiated by an accelerated charge.	**10**
	Physics of Plasmas Electrical neutrality in a plasma, Particle orbits and drift motion in a plasma, Magnetic mirrors, The hydro- magnetic equations, The pinch effect, Plasma oscillations and wave motion, Reflection from a plasma (ionosphere).	**9**
	Wave Guides Propagation of Waves between conduction planes, Wave guides in arbitrary cross-section, Wave -guides in Rectangular Cross-section, Coaxial Wave guide, Resonant Cavities, Dielectric wave guides.	**10**
	Relativistic Electrodynamics Lorentz transformation as four-dimensional orthogonal transformation, Lorentz matrix, four vectors in mechanics and electrodynamics, Lorentz covariance of Maxwell equations, field tensor, transformation of fields, field due to a point charge in uniform motion.	**12**
Pedagogy:	Lectures/ tutorials/ assignments. Sessions shall be interactive in nature to enable peer group learning.	
References/Readings	**Text Books / References:** 1. J. B. Marion, Classical Electromagnetic Radiation, Academic Press, New York (1980). 2. J. R. Reitz and F. J. Milford, Foundations of Electromagnetic theory, Addison – Welsey, Reading (1960). 3. B. B. Laud, Electromagneties, Wiley Eastern Ltd., New Delhi (1983).	

	4. S. P. Puri, Classical Electrodynamics, Tata McGraw-FEII Publishing Co. Ltd. New Delhi (1997). 5. David J. Griffiths, Introduction to Electrodynamics, Prentice - Hall of India Pvt. Ltd., New Delhi (1995). 6. J. D. Jackson, Classical Electrodynamics, Wiley, New York (1995). 7. W. H. Panofsky and M. Philips, Classical Electricity and Magnetism, Addison-Wesley Publication, 1962.
Course Outcomes:	Student will be able to 1. Analyse the nature of electromagnetic fields due to time varying charge and current distribution using Maxwell's equations. 2. Describe the properties of plane waves in unbounded space, and understand such concepts as wavelength, phase velocity, and attenuation. 3. Develop fundamental concepts of plasma systems using the concepts of electromagnetic theory. 4. Apply equations of electromagnetism to the analysis of waveguides. 5. Develop an understanding of the principles of relativistic electrodynamics.

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-403**
Title of the Course : **Physics Laboratory - III**
Number of Credits : **4P**
Effective from AY : **2024-25**

Pre-requisites for the course:	Basic knowledge of Electronics	
Course Objectives:	This course provides laboratory training in designing, and constructing electronics circuits commonly used in a Physics laboratory.	
		No. of Hours
Content:	Experiments are to be performed on following topics (minimum 12) with emphasis on designing and constructing the circuit on a bread board. 1. Design and construction of CE amplifier with voltage divider bias 2. Design and construction of active low pass, high pass and band pass filter using op-amps of type Butterworth/ Chebyshev/ Bessel/ Legendre-Papoulis/ Elliptical/Linkwitz 3. Design and construction of analog circuit to solve differential equation of the type 4. Design and construction of Instrumentation amplifier 5. Design and construction of digital voltmeter 6. Design and construction of counter that can count from 000 to 999 7. Design and construction of temperature monitoring system using transducer like LM35 8. Design and construction of magnetic monitoring system using transducer like KY-024/41F/49E 9. Design and construction of LVDT system for monitoring displacement 10. Design and construction of Strain gauge system for measuring displacement/strain 11. Design and construction of Analog to Digital system 12. Design and construction of Digital to Analog system 13. Design and construction of a Phase locked loop system using IC 565 14. Design and construction of log/antilog amplifier 15. Design and construction of Window comparator 16. Design and construction of Voltage to current and Current to voltage convertor 17. Design and construction of Frequency to voltage converter. 18. Design and Construction of Function generator 19. Design and construction of Negative nonlinear resistor	**120**
Pedagogy:	Laboratory Experiments	

References/ Readings	1. D. P. Leach, A. P. Malvino and G. Saha, Digital Principles and Applications. Tata Mc Graw Hill 7e, 2011. 2. J. Millman and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems. McGraw Hill International Student Ed., 1972. 3. Wikibooks – Negative resistance, Negative differential resistance. 4. https://en.wikibooks.org/wiki/Circuit_Idea
Course Outcome:	Student will be able to 1. Prepare for laboratory work, by reading from books / laboratory manual / datasheet. 2. Design and construct electronic circuits by identifying and fetching different components. 3. Record observations from different measuring instruments and record them neatly. 4. Plot graphs and analyze the results. 5. Demonstrate the ability to maintain a laboratory notebook. 6. Prepare lab reports in standard scientific format.

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-404**
Title of the Course : **Quantum Mechanics - II**
Number of Credits : **4L**
Effective from AY : **2024-25**

Pre-requisites for the course:	Studied Physics, including an introductory course on Quantum Mechanics at graduate level	
Course Objectives:	1. To develop basic formalisms of non-relativistic Quantum Mechanics. 2. To illustrate the concepts for analyzation of simple quantum mechanical systems	
Content:		**No. of Hours**
	Schrodinger's Equation and Hermitian operators (a) Time-dependent Schrodinger equation, continuity equation, expectation values, Ehrenfest's theorems, time- independent Schrodinger equation and stationary states. (b) Hermitian operators, eigenvalues and eigenstates of Hermitian operators, momentum eigenfunctions, orthogonality and completeness of wave functions, Computability and compatibility of observables, parity operation.	**8**
	The Schrodinger equation in three dimensions Separation of the Schrodinger equation in Cartesian coordinates, Central potential, separation of the Schrodinger equation in spherical polar coordinates, The free particle, The three-dimensional square well potential, The hydrogen atom, The three-dimensional isotropic oscillator.	**12**
	Vector space formulation of quantum mechanics Dirac Notation, representation of states and observables, bra and ket vectors, linear operators, relation with wave mechanics, algebra of Hermitian operators, matrix representation, unitary operators, Schrodinger and Heisenberg representations, linear harmonic oscillator problem by operator method.	**5**
	Angular Momentum theory Angular Rotations in Classical and Quantum Mechanics, Rotational Symmetry and conservation of angular momentum, Treatment of general angular momentum by operator method, eigenvalues and eigenvectors, Eigen values and eigenfunctions of L^2 and Lz operators, ladder operators L^+ and L^-, spin angular momentum, algebra of Pauli matrices, Pauli representation of angular momentum operators. Addition of two angular momenta, spin-orbit interaction, Clebsch Gordon coefficients.	**10**
	Approximation methods for stationary problems Time-independent perturbation theory for a non-degenerate energy level, Time-independent perturbation theory for a degenerate energy level, The variational method, The WKB approximation.	**8**
	Approximation methods for time-dependent problems	**7**

	Time-dependent perturbation theory, General features, Time-independent perturbation, periodic perturbation, The adiabatic approximation, The sudden approximation	
	Quantum Collision Theory Scattering experiments and cross-sections, potential scattering and general features, the method of partial waves, Application of the partial-wave method, the integral equation of potential scattering, The Born approximation, Collision between identical particles, Collision involving composite systems.	**10**
Pedagogy:	lectures/ tutorials/ assignments. Sessions shall be interactive in nature to enable peer group learning.	
References/Readings	**Text Books / References** 1. A. K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer (2004) 2. David J. Griffiths, Introduction to Quantum Mechanics 2/e, Cambridge India, (2016). 3. J. J. Sakurai Modern Quantum mechanics, Addition- Wesley Publishing Company, (1994). 4. L. I. Schiff and Jayendra Bandhyopadhyay, Quantum Mechanics, 4/e, McGraw-Hill (2017). 5. Nouredine Zettili, Quantum Mechanics: Concepts and Applications 2/e, Wiley India (2016) 6. P. M. Mathew and K. Venkatesan, A Text Book of Quantum Mechanics, 2/e, Tata McGraw Hill (2017) 7. R. Eisberg and R. Resnick, Quantum Physics of atoms, molecules, solids, nuclear and particles, 2/e, John Wiley and Sons, (1985). 8. R. L. Liboff, Introductory Quantum Mechanics, 4e, Pearson Education Ltd (2003). 9. V. Devanathan, Quantum Mechanics, 2/e Narosa Publishing House (2015). 10. V. K. Thankappan, New Age International Publishers (2012)). 11. W. Greiner, Introductory Quantum mechanics, Springer Publication, (2001).	
Course Outcomes:	Students will be able to 1. solve wave equations for simple three-dimensional systems. 2. Acquire knowledge and skills to describe the structure of the hydrogen atom and show an understanding of quantisation of angular momentum and spin as well as the rules for quantisation and addition of these. 3. understand the concepts of approximation methods for solving Schrodinger equations 4. gain the knowledge about fundamental scattering of quantum particles.	

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-405**
Title of the Course : **Statistical Mechanics**
Number of Credits : **4L**
Effective from AY : **2024-25**

Pre-requisites for the course:	Should have studied Physics or Mathematics at graduation level. It is assumed that students have a basic working knowledge of classical and quantum mechanics, including Hamiltonian formulation and density matrices.	
Course Objectives:	This course develops concepts in classical laws of thermodynamics and their application, postulates of statistical mechanics, statistical interpretation of thermodynamics, microcanonical, canonical and grant canonical ensembles; the methods of statistical mechanics are used to develop the statistics for Bose-Einstein, Fermi-Dirac and photon gases.	
		No. of Hours
Content:	**Kinetic Theory and Equilibrium state of Dilute Gas** Formulation of problem, binary collisions, Boltzmann transport equation, Boltzmann's H theorem, Maxwell- Boltzmann distribution, Method of the most probable distribution, analysis of the H theorem, recurrence and reversal paradoxes, Validity of the Boltzmann transport equation.	**12**
	Classical Statistical Mechanics Review of laws of thermodynamics, Entropy, Thermodynamic Potentials, Postulate of Classical Statistical Mechanics, Microcanonical ensemble, derivation of thermodynamics, equipartition theorem, Classical ideal gas, Gibbs paradox.	**12**
	Canonical and Grand Canonical Ensembles Canonical ensemble, energy fluctuations in canonical ensemble, grand canonical ensemble, density fluctuations in grand canonical ensembles, equivalence of canonical and grand canonical ensembles, behaviour of W(N), meaning of Maxwell construction.	**12**
	Quantum Statistical Mechanics Postulates of quantum statistical mechanics, density matrix, ensembles in quantum mechanics, third law of thermodynamics, ideal gases in microcanonical and grand canonical ensembles, foundations of statistical mechanics.	**8**
	Ideal Fermi Gas Equation of state of Ideal Fermi Gas, theory of white dwarfs, Landau diamagnetism, de Hass-Van Alphen effect, Pauli paramagnetism.	**8**
	Ideal Bose Gas Photons, phonons, Bose-Einstein condensation.	**8**
Pedagogy:	Lectures/ tutorials/assignments. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. B. B. Laud, Fundamentals of Statistical Mechanics, New Age International Ltd. New Delhi 1998. 2. F. Reif, Fundamentals of Statistical and Thermal Physics, Waveland Press 2009.	

	3. Francis W. Sears and Gerhard Salinger, Thermodynamics, Kinetic Theory, and Statistical Thermodynamics, Addison-Wesley Principles of Physics Series, 1975. 4. Kerson Huang, Statistical Mechanics, 2/e, Wiley India 2008. 5. L. D. Landau and E. M. Lifshitz, Statistical Mechanics, Pergamon Press 1969. 6. R. P. Feynmann, Statistical Physics, The Benjamin Cummings Publishing Co 1981. 7. S. K. Sinha, Introduction to Statistical Physics, Narosa Publishing House, New Delhi 2007. 8. Tony Guenault, Statistical Physics, New Age International Ltd. New Delhi 2007.
Course Outcomes:	Students will be able to: 1. Connect between statistics and thermodynamics. 2. differentiate between different ensemble theories used to explain the behaviour of the systems. 3. differentiate between classical statistics and quantum statistics. 4. explain the statistical behaviour of ideal Bose and Fermi systems. 5. Apply techniques from statistical mechanics to a range of situations.

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-406**
Title of the Course : **Nuclear and Elementary Particle Physics**
Number of Credits : **4L**
Effective from AY : **2024-25**

Prerequisites for the course:	Concepts like Radioactivity, Nuclear fission, and knowledge of solution of 1 dimensional Schrodinger Equation	
Course Objectives:	To introduce students to the fundamental principles and concepts governing nuclear and particle physics and have a working knowledge of their application to real-life problems.	
Content:		**No. of Hours**
	Basic Properties of Nuclei: a. Nuclear mass, charge, radius, binding energy, nuclear spin, and parity. b. Magnetic moments and electric quadrupole moments.	**8**
	Two-Body Problem: a. Brief review of quantum mechanics tools, properties of deuteron, theory of the ground state of deuteron, magnetic moment, and electric quadrupole moment of deuteron. b. Theory of nucleon-nucleon scattering at low energy, phase shift and scattering length, effective range theory, experimental determination of low energy parameters. c. Nature of nuclear forces and Meson theory of nuclear force.	**12**
	Nuclear Models: a. Liquid drop model, Weizsacker's mass formula, stable and unstable nuclei, mass parabolas. b. Nuclear shell model, energy levels in a three-dimensional harmonic oscillator well potential, spin orbit interaction, prediction of magic numbers, ground state spins and parities, c. Magnetic moments, Schmidt lines, nuclear quadrupole moments, and collective model.	**10**
	Nuclear Transformations: a. Alpha decay, barrier penetration problem, Gamow's theory of alpha decay, Geiger-Nuttal law, alpha spectra and nuclear energy levels. b. Beta decay, experiments in beta spectra, neutrino hypothesis, Fermi's theory of beta decay, Kurie plots, ft values, allowed and forbidden transitions, selection rules, electron capture, parity violation in beta decay, experimental verification, measurement of neutrino helicity. c. Gamma transitions, multipole radiations, quantum theory of the transition probability, selection rules, angular correlation, calculations of transition rates and comparison with experiments, internal conversion	**10**

	Nuclear Reactions: a. Rutherford scattering, cross-sections, decay rates, resonances, Breit-Wigner formula, nuclear fission and fusion processes.	**4**
	Elementary Particles: a. Classification of elementary particles; properties of quarks and leptons, properties of mesons and baryons. Classification of fundamental forces; Strong, Weak and Electromagnetic interactions. b. Introduction to Feynman diagrams, relativistic kinematics, quark model and eightfold way. c. Particle quantum numbers; charge, isospin, strangeness and parity, Gell-Mann Nishijima formula, conservation laws and symmetries.	**10**
	Particle accelerators and detectors: a. Introduction to modern accelerators, event rates and luminosity. Large detector systems at electron-positron, electron-proton and hadron colliders. b. Interaction of particles with matter, principle of gas chambers, silicon detectors, scintillators, time-of-flight detectors, and calorimetry.	**6**
Pedagogy:	Lectures / tutorials/assignments. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. H. Enge, Introduction to Nuclear Physics, Addison- Wesley (1974). 2. E. Segre, Experimental Nuclear Physics, John Wiley (1960). 3. V. Devanathan, Nuclear Physics, Alpha Science International Ltd, (2011). 4. S. N. Ghoshal, Nuclear Physics, S. Chand and Co. (2019)	
Course Outcomes:	Student will be able to 1. Apply the models describing the basic nucleon and nuclear properties. 2. Describe the properties of strong and weak interaction. 3. Explain the different forms of radioactivity and account for their occurrence. 4. Classify elementary particles and nuclear states in terms of their quantum numbers.	

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-407**
Title of the Course : **Physics Laboratory - IV**
Number of Credits : **4P**
Effective from AY : **2024-25**

Prerequisites for the course:	Nil	
Course Objectives:	This course provides laboratory training in performing experiments that verify important physical laws and using modern and novel techniques of measurements.	
		No. of Hours
Content:	Short Lecture Course on – Theory of errors, Treatment of Errors of observation, linear least squares fitting and Data analysis. The experiments on the following topics (any 12) are to be performed with emphasis on the estimation and calculation of errors. 1. Types of Statistical Distributions 2. Analysis of Sodium Spectrum – Quantum defect and Effective quantum number 3. Michelson Interferometer/Fabry-Perot Interferometer 4. Diffraction experiments using laser– single slit, double slit, grating 5. Polarization experiments using laser –linearly and elliptically polarized light 6. Statistical Distribution of radioactive decay 7. Verification of Inverse Square Law using GM counter 8. Linear Absorption Coefficient of Aluminium using GM counter 9. Verification of Debye Relaxation Law and measurement of thermal relaxation of serial light bulb 10. Thermal diffusivity of Brass 11. Thermometry – measurement of thermoemf of Iron- Copper (Fe-Cu) thermocouple as a function of temperature and verification of law of intermediate metals 12. Calibration of Lock-in Amplifier 13. Measurement of mutual inductance of a coil using lock-in amplifier 14. Measurement of low resistance using lock-in amplifier 15. X-ray Emission – characteristics lines of a W target 16. Experiments using Strain Gauge 17. Ultrasonic Interferometer 18. Nonlinear dynamics – Feigenbaum circuit 19. Nonlinear dynamics – Chua's circuit 20. Verification of Percolation phenomena 21. Measurement of electrical resistance of Ni wire to verify para to ferromagnetic phase transition	**120**

	22. Measurement of electrical resistance of NiTi based shape memory alloy 23. Measurement of Young's modulus of Brass by Flexural vibrations
Pedagogy:	Lectures and Laboratory Experiments.
References/ Readings	1. P. R. Bevington and D. K. Robinson, Data Reduction and Error Analysis for the Physical Sciences. McGraw Hill (Indian Edition), 2015. 2. R. Srinivasan, K. R. Priolkar, and T. G. Ramesh, A Manual on Experiments in Physics. Indian Academy of Sciences, 2018.
Course Outcomes:	Student will be able to 1. Employ proper techniques when making scientific measurements. 2. Demonstrate the ability to use selected pieces of measuring devices including the multimeter, oscilloscope, and AC and DC power supplies, Lock-in Amplifier. 3. Apply the appropriate physics to the physical situation presented. 4. Estimate and translate errors and report quantities up to last significant digit. 5. Formulate and report scientific conclusions based on data analysis.

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-411**
Title of the Course : **Introduction to Solids**
Number of Credits : **4L**
Effective from AY : **2024-25**

Prerequisites for the course	Basic knowledge of Quantum Mechanics	
Course Objectives	To introduce fundamental concepts of solids, their structure and properties.	
Content		**No. of Hours**
	Crystal Structure Crystalline and Amorphous Solids, Crystals - Lattice, Bravais lattice, primitive unit cell, Lattices in one, two and three dimensions, definitions of directions, coordinates and planes. Simple crystal structures: NaCl, CsCl, diamond, cubic ZnS structure and their properties. Determination of Crystal structure – Bragg's Law	**12**
	Electronic Structure Free electron theory – Drude model - assumptions, failures of Drude model, Sommerfeld model, Successes and failures of the Sommerfeld model, Electrical conductivity, Experimental electrical resistivity of metals, Heat capacity of electron gas, Experimental heat capacity. Bands in a solid, Kronig-Penny Model, Metals and Insulators	**12**
	Thermal Properties Elastic Waves, Enumeration of modes, Density of states of a continuous medium, Specific heat, Debye model, Einstein model, Phonon, Thermal conductivity - Thermal resistivity of phonon gas, Umklapp process.	**12**
	Optical and Dielectric Properties Macroscopic electric field, local electric field at atom, dielectric constant and polarizability, Optical reflectance, Excitons, Raman effect in crystals. Luminescence and Luminescence centres.	**9**
	Magnetic Properties Magnetic moments, Quantum mechanics of spin, Atom in mangetic field, Magnetic susceptibility, Diamagnetism, Paramagnetism, Semiclassical treatment, Quantum Theory of Paramagnetism, Hund's Rules, Crystal field, Paramagnetic Susceptibility of Conduction electrons, Van Vleck paramagnetism, Adiabatic demagnetization, Ferromagnetism, The Weiss model of a ferromagnet, Origin of molecular field, Magnons, Domains, Antiferromagnetism, Neel's theory, Ferrimagnetism	**15**
Pedagogy	Lectures/ tutorials/ assignments. Sessions will be interactive in nature to enable peer group learning.	

References/ Readings	1. A. J. Dekker, Solid State Physics, McMillan, India (1985) 2. C. Kittel, Introduction to Solid State Physics, Wiley India (2019) 3. M. A. Omar, Elementary Solid State Physics; Principles and Applications, Pearson/Addison Wesley (2002) 4. Niel W. Ashcroft, N. David Mermin, Solid State Physics, Harcourt Asia Pte Ltd. (2001) 5. R. K. Puri and V. K. Babbar, Solid State Physics, S. Chand and Co. (2010)
Course Outcomes	Student will be able to 1. Understand the fundamental aspects related to structure of solids, lattice symmetry, and structure determination. 2. Understand basics of electronic structure of solids 3. Gain insights about phonons and their role in thermal and optical properties of solids. 4. Appreciate magnetic and transport properties of solids

Name of the Programme : **B. Sc. (Physics)**
Course Code : **PHY-413**
Title of the Course : **Atomic Physics**
Number of Credits : **4L**
Effective from AY : **2022-2023**

Prerequisites for the Course:	Knowledge of concepts like Bohr model of atom, Electronic transition in atoms and atomic spectra.	
Course Objectives:	This course is aimed at understanding the atomic structure and atomic spectra	
Content:		**No. of Hours**
	Early Atomic Physics Atomic spectra of hydrogen, The Bohr's theory, Relativistic effects, Moseley and atomic number, Radiative decay, Einstein A and B coefficients, The Zeeman effect.	**6**
	One-electron atoms: The Schrödinger equation for one-electron atoms, energy levels, the Eigen functions of the bound states, expectation values. Transitions, selection rules, parity, spin of the electron, the spin-orbit interaction, Fine structure of hydrogenic atoms, The Lamb shift, transitions between fine-structure levels.	**12**
	Two-electron atoms: The Schrödinger equation for two-electron atoms, The ground state of two-electron atoms, Excited states of two-electron atoms. Doubly excited states of two electron atoms.	**12**
	Many-electron atoms: Shell structure and the periodic table, The central field approximation, The Hartree-Fock method and the self-consistent field, Corrections to the central field approximation. Correction effects, *L-S* coupling and *j-j* coupling. Fine structure in the alkalis.	**15**
	Interaction of atoms with electromagnetic radiation and with static and magnetic field: Many electron atoms in an electromagnetic field, selection rules for electric dipole transitions, Oscillator and line strengths, Retardation effects, Magnetic dipole and electric quadrupole transitions, The spectra of the alkalis, Helium and the alkaline earths, Atoms with several optically active electrons, Multiplet structure, X-ray spectra, The stark effect, The Zeeman effect.	**15**
Pedagogy:	Lectures/tutorials/assignments. Sessions shall be interactive in nature to enable peer group learning	
References/ Readings	1. C. J. Foot, Atomic Physics, Oxford Master Series in Physics (2005) 2. B. H. Bransden, C. J. Joachain, Physics of Atoms and Molecules, Pearson (2004) 3. D. C. Jones, Atomic Physics, CRC Press/Sarat Book House (2018) 4. S. N. Ghoshal, Atomic Physics, S. Chand Publishing (2007)	

Course Outcomes:	Students will be able to 1. understand electronic structure of single electron and multielectron atoms 2. calculate fine structure of atoms 3. deduce the atomic spectra of simple atoms 4. understand the interaction of atoms with electric and magnetic fields.